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Assessing golf and health, and investigating how the evidence base can impact policy and practice



Thesis submitted for the degree of Doctor of Philosophy
The University of Edinburgh

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Dr Andrew Murray

2020

Declaration of authorship

This PhD is my own work and has not been submitted for any other professional qualification or degree. I have received input and support from my supervisors Professor Nanette Mutrie, Professor Liz Grant, and Dr Paul Kelly throughout. Dr Roger Hawkes has been actively involved in generating ideas throughout the PhD.

I have highlighted in this declaration of authorship, and in the text where input has been received from other persons. This is limited to where jointly authored publications have been included. My contribution to those studies, and those of other authors have been acknowledged below.

A handwritten signature in black ink, appearing to read 'A. Murray', is written over a solid black rectangular background.

Publications in peer reviewed journals

Chapter Two

Murray, A. D., Daines, L., Archibald, D., Hawkes, R. A., Schiphorst, C., Kelly, P., ... & Mutrie, N. (2017). The relationships between golf and health: a scoping review. *Br J Sports Med*, 51(1), 12-19.

I led the development of the research questions and study design working with supervisors and all other authors. With Prof Liz Grant and Prof Nanette Mutrie, I identified the method whilst working with Dr Daryll Archibald to identify existing scoping review frameworks to develop a protocol. I developed the search strategy and data extraction form with supervisors and conducted data extraction with Dr Luke Daines. I led the development of the first and subsequent drafts of the manuscript. All authors reviewed and approved the manuscript.

Chapter Three.

Murray, A. D., Turner, K., Archibald, D., Schiphorst, C., Griffin, S. A., Scott, H., ... & Mutrie, N. (2017). An observational study of spectators' step counts and reasons for attending a professional golf tournament in Scotland. *BMJ Open Sport & Exercise Medicine*, 3(1), e000244.

I led the development of research questions and study design, working with Kieran Turner, Dr Paul Kelly, Prof Liz Grant and Prof Nanette Mutrie. I led data collection, supported with some data collected by Kieran Turner, Chloe Schiphorst, Steffan Griffin and Hilary Scott due to volume of participants. I processed the data and led the development of the first and subsequent drafts of the manuscript. All authors reviewed and approved the final manuscript.

Murray, A. D., Hawkes, R. A., Kelly, P., Grant, L., & Mutrie, N. (2019). Do golf fans walk the talk? Follow-up of spectators' beliefs and self-reported physical activity 3 months after they attended a professional golf tournament in the UK. *BMJ Open Sport & Exercise Medicine*, 5(1), e000503.

I led the development of research questions and study design, working with Dr Paul Kelly, Prof Liz Grant and Prof Nanette Mutrie. I collected and processed the data. I led the development of the first and subsequent drafts of the manuscript. All authors reviewed and approved the final manuscript.

Chapter Four.

Murray, A. D., Archibald, D., Murray, I. R., Hawkes, R. A., Foster, C., Barker, K., ... & Mutrie, N. (2018). 2018 International Consensus Statement on Golf and Health to guide action by people, policymakers and the golf industry. *Br J Sports Med*, 52(22), 1426-14361.

I designed the study methods with Dr Iain Murray, Dr Paul Kelly, Prof Nanette Mutrie and Prof Liz Grant, and conducted the literature search, and drafted the questionnaire with IM, PK, NM, LG, Dr Roger Hawkes, and Kevin Barker. I analysed the data and developed the first and subsequent drafts of the manuscript. All authors reviewed and approved the manuscript.

Chapter Five

Murray, A., Kelly, P., Morton, S., Glover, D., Duncan, J., Hawkes, R., ... & Mutrie, N. (2019). Maximising and evaluating the uptake, use and impact of golf and health studies. *Br J Sports Med*. Online first.

I designed the study method with input from Dr Sarah Morton, Dr Paul Kelly, Prof Nanette Mutie and Prof Elizabeth Grant, collected and analysed data, and engaged with key stakeholders. I developed the first and subsequent drafts of the manuscript. All authors reviewed and approved the final manuscript.

Protocols published in peer reviewed journals

Chapter Two

Murray, A., Daines, L., Archibald, D., Hawkes, R., Grant, L., & Mutrie, N. (2016). The relationship and effects of golf on physical and mental health: a scoping review protocol. *Br J Sports Med*, 50(11), 647-650.

Link to full article provided in chapter two. Full article presented in Appendix 4 of this thesis. I selected the Scoping Review method with my supervisors and identified existing frameworks to develop this scoping protocol with Dr Daryll Archibald. I developed search terms and a search strategy with research librarian Marshall Dozier. I developed the research questions and study design with my supervisors. I developed the first and subsequent drafts of the manuscript with all authors who also reviewed and approved the manuscript.

Infographics and knowledge translation articles published in peer reviewed journals

Chapter Two

Murray, A. D., Daines, L., Archibald, D., Hawkes, R. A., Schiphorst, C., Kelly, P., ... & Mutrie, N. (2017). Infographic. Golf and health. *Br J Sports Med*. Online first.

I led the development of the content for the infographic working with supervisors and all other authors. With Chloe Schiphorst, I developed and refined the visual content. All authors reviewed and approved the manuscript.

Chapter Three

Murray, A., Scott, H., Archibald, D., Turner, K., Griffin, S. A., Schiphorst, C., ... & Mutrie, N. (2018). Infographic. Golf spectating and health. *Br J Sports Med*, 52(6), 415-416.

I led the development of the content for the infographic working with supervisors and all other authors. With Hilary Scott, I developed and refined the visual content. All authors reviewed and approved the manuscript.

Chapter Four

Murray, A. D., Barton, C. J., Archibald, D., Glover, D., Murray, I. R., Barker, K., & Hawkes, R. A. (2018). Infographics and digital resources: an international consensus on golf and health. *Br J Sports Med*, 52(22), 1421-1425.

I led the development of the content for the infographics working with supervisors and all other authors. With Dr Danny Glover I developed and refined the visual content. All authors reviewed and approved the manuscript.

Elsewhere, acknowledgement has been made as appropriate by way of reference to the work of others.

Abstract.

Golf is a sport played by over 60 million people in over two-thirds of countries worldwide. This thesis contributes knowledge regarding what is known about golf and health, and what can be advised to maximise health benefits, and minimise the health dis-benefits of golf, and assesses the impact of this knowledge for the golf industry and policy makers. The first chapter describes the scientifically well-established longevity, physical and mental health benefits of regular physical activity, and provides background information on golf. Following this introductory chapter, this thesis first identifies, and then addresses some critical gaps in the literature on the associations between golf and health.

The second chapter of the thesis presents a scoping review assessing the relationships between golf and health. Three hundred and one studies met inclusion criteria for the scoping review. The studies showed that golf can provide moderate intensity physical activity and is associated with health benefits that include improved cardiovascular, respiratory and metabolic profiles, and improved wellness. There is limited evidence relating to mental health, while regarding longevity there was some evidence for benefits of golf, but more robust studies are required. No measures of physical activity obtained by golf spectators had been reported.

The third chapter of the thesis addresses one of the evidence gaps identified by the scoping review, this is the area with least existing evidence, and relates to physical activity (PA) obtained by spectators. An initial cross-sectional study of n=339 spectators at a 4-day 2016 UK golf tournament used pedometers and surveys to investigate PA behaviours and attitudes. Findings highlighted that obtaining exercise/PA can be a motivator to attend, and that spectators can engage in health-enhancing physical activity (HEPA) while at the event with 82.9% obtaining the recommended daily step count while spectating. A follow up study of n=135 spectators who responded to an online questionnaire three months post intervention showed that a 40.4% of spectators do self-report an increase in PA during the 3 months post intervention at a golf tournament. These are important findings as golf spectating has high global participation and potential for impact is therefore high. However, it is not yet clear if the results from these two novel studies are generalisable.

Having conducted the scoping review, I identified the absence of coherent scientific advice to/for players, the golf industry, and policy makers. I aimed to address this in the fourth chapter of the thesis and describe the modified Delphi methods used to engage leaders at the

intersection of health, sport, policy and golf to build a cross-sectoral consensus statement relating to golf and health. Consensus findings, and their implications for players, the golf industry and facilities and policy makers are described.

Measuring the uptake, use and impact of research is imperative to demonstrate value to funders and employers, and to highlight and support further knowledge translation and decision-making efforts. The fifth chapter provides a novel Research Impact tool and utilises the established Research Contribution Framework to explore and explain the uptake, use and impact of the studies in this thesis. There is clear evidence that the work contained in this thesis has had wide uptake and use.

Chapter 6 provides discussion of the thesis overall, analysing key findings, reflecting on strengths and weaknesses of the work, and making recommendations for policy, practice and future research. This thesis has assessed current knowledge regarding golf and health, conducted original research to address knowledge gaps, provided guidance to key stakeholders, and evaluated the uptake, use and impact of our work. The best available evidence highlights physical health, well-being and probable longevity benefits for golf participants. Health enhancing physical activity can also be achieved by spectators at professional golf tournaments. There is evidence of strong uptake and use of the research in this thesis. If practical recommendations contained in this thesis to i) golfers and potential golfers ii) the golf industry and facilities iii) policy makers iv) the scientific community, are adopted, this will contribute to increased inclusivity, and improved health through golf.

Lay Summary

Golf is a sport played by over 60 million people in over two thirds of countries worldwide. This work explores the relationships between golf and health.

The first chapter describes the health benefits of physical activity, including longer length of life, and overall improved physical and mental health. A study pulling together the available evidence (scoping review) in the second chapter outlines what we know about golf and health. Golf enables players to be physically active. This activity may have benefits for the heart, lungs and help reduce cholesterol. A number of the studies suggested golf can improve well-being. Priority areas for further study are described including assessing physical activity obtained by spectators at events.

The thesis then explored if those watching golf could gain physical activity and therefore health benefits. We assessed whether spectators at golf tournaments can benefit their health while at the event. Spectators gained on average over 11,000 steps, and of those surveyed three months later, some described being more active in day to day life.

The overall results of the thesis showed that the links between golf and health are important in helping people become and stay healthy. The thesis explored taking this knowledge and sharing it with the players, the golf industry and decision makers on how to maximise health benefits of golf and minimise any risks of golf. In chapter four I describe how an International Consensus (agreement) on Golf and Health was reached.

I then assess whether the science in this thesis is being used and is making a difference in chapter five. There is clear evidence that the golf industry, national governments and golfers are using this work. The thesis findings will provide a basis for future research and initiatives to make golf more available to all.

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Background to the thesis and the author

My passion and professional remit are in public health. My professional qualifications are as a General Practitioner, and consultant in Sport and Exercise Medicine. I gained experience from a policy perspective in roles with medical royal colleges (physical activity lead for the Royal College of Physicians and Surgeons of Glasgow 2014-2015), the Scottish Government (Physical Activity Champion 2012-2013), and Ramblers Scotland (President/ Vice-President (2014- present). My research interests lie principally within physical activity for health, and sports and exercise medicine. A brief CV is shown in Appendix 1.

In 2014 the World Golf Foundation indicated an appetite to fund research looking at the relationships between golf and health following conversations between their senior leadership and Dr Roger Hawkes who is a sports and exercise medicine physician. This presented a unique opportunity for me given my role with the European Tour Golf/ European Tour Performance Institute (currently Chief Medical Officer), wide interest in physical activity for health, and the opportunity to work with Profs Mutrie and Grant as supervisors at the University of Edinburgh. We applied for funding to the WGF in late 2014 and the PhD work commenced in Aug 2015 on a part-time five year programme. Dr Kelly joined the supervision team in Jan 2016. All parties agreed to publication of findings, regardless of whether they could be seen to be beneficial, or not beneficial for golf.

Funding and supervision arrangements

Funding

Funding has been provided by an unrestricted grant from the World Golf Foundation (WGF). Funding is frequently received from industry partners for research, and in line with university best practice and to minimise any conflict of interest, it was agreed and minuted in advance that findings whether positive or negative will be published as a thesis and submitted to peer reviewed journals. No World Golf Foundation board members were co-authors nor had any editorial control over the findings within the thesis or peer reviewed publications. Industry involvement can be a limitation due to risk of bias but can be a strength in practical implementation. The funding was for 5 years of part time study 0.6 full-time equivalent, and commenced in August 2015, with the thesis and projects due to conclude in August 2020.

Supervision

Supervision is provided by Professor Nanette Mutrie M.B.E, Professor Liz Grant and Dr Paul Kelly. I have collaborated in previous policy roles with Professor Mutrie, a recognised world leader in physical activity for health research and policy and Director of the Physical Activity for Health Research centre (PAHRC). Professor Liz Grant, Director of the Global Health Academy/ Assistant Principal Global Health is expert in bringing a wide public health, non-communicable disease, and international perspective. Dr Kelly is a lecturer in Physical Activity for Health in PAHRC. He is on the executive committee of the International Society of Physical Activity for Health and the 2019 UK CMO Physical Activity Guidelines Update Expert Group.

Further input and regular guidance was provided throughout by

- Dr Roger Hawkes, President of the British Association of Sport and Exercise Medicine, and executive director of the Golf and Health project for the World Golf Foundation (WGF). Dr Hawkes is an independent consultant, external to the WGF specifically appointed by WGF to lead the project to ensure robust, transparent scientific methods were utilised.
- Prof Karim Khan Editor-in-chief of the British Journal of Sports Medicine.

Support regarding specific methodological aspects of the research was received as below:

Scoping Review- Dr Daryll Archibald. Lecturer in Public Health, University of LaTrobe, Australia.

Consensus Statement using modified Delphi method- Dr Iain Murray. Clinical lecturer, University of Edinburgh.

Evaluation of uptake, use and impact- Dr Sarah Morton. Matter of Focus. Edinburgh.

Timeline

Figure 1 (below) shows a timeline highlighting work on each study and on other activities. The scoping review commenced after planning meetings with the research team and relevant stakeholders. As the knowledge gap on spectator health emerged, the golf spectator studies were commenced to address this. With golfers and golf industry leaders seeking practical actions they could undertake regarding golf and health, a rigorously conducted consensus on golf and health helped achieve this. I then evaluated the uptake, use and impact of these prior studies.

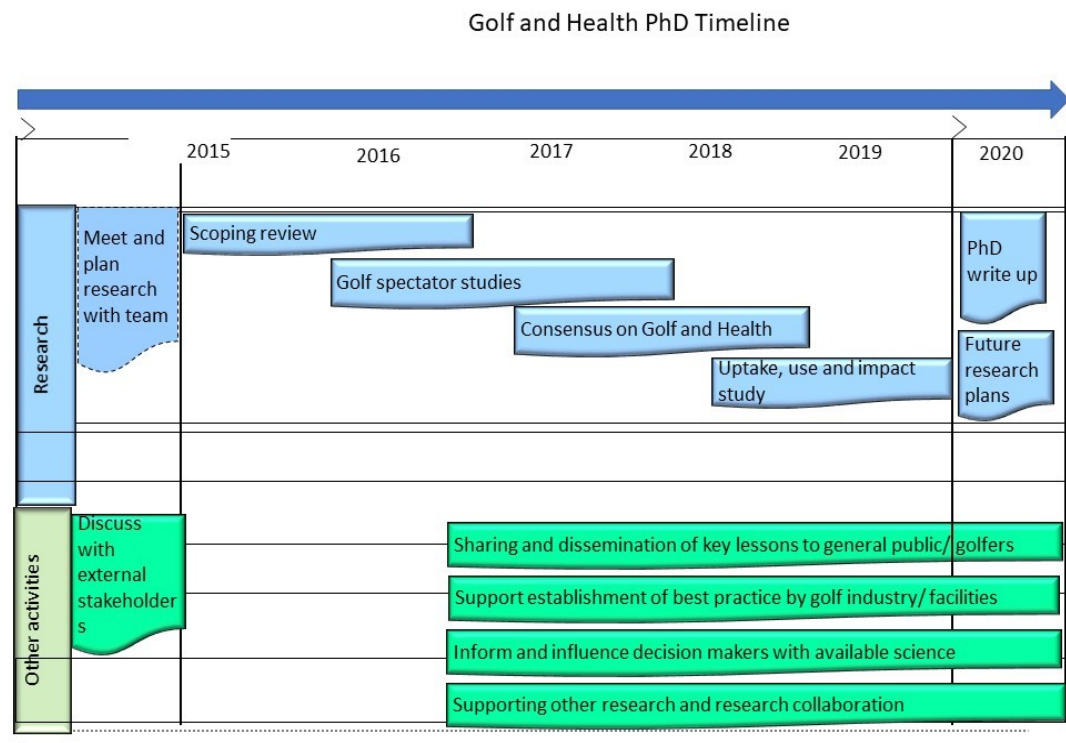


Figure 1. Timeline of thesis activities.

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I would like to acknowledge my supervisors Professor Nanette Mutrie and Dr Paul Kelly (Physical Activity for Health Research Centre) and Professor Liz Grant (Global Public Health) who have provided outstanding support, guidance, feedback and regular physically active breaks.

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In order to maximise potential impact of this thesis, consultation was undertaken throughout with a wide range of stakeholders that constitute end-users of the research. This work was informed by conversations with these individuals and organisations highlighted in the acknowledgements. Valuable input has been received from leaders in public health policy which include:

Professor Fiona Bull, and Daniel Friedman- World Health Organisation;
Professor Charlie Foster- President of the International Society of Physical Activity for Health;
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Stephen Gethins MP, Craig Tracey MP, and the All Party Parliamentary Group for Golf;
Aileen Campbell MSP, Jeane Freeman MSP, and Joe Fitzpatrick MSP, Ministers for Health, Public Health and Sport, Scottish Government;
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Wade Aubry, Institute for Health Policy, University of Southern California, San Francisco.

Valuable input has been received from leaders from the golf industry, who include Steve Mona and Greg McLaughlin (successive Chief Executives) and Dr Roger Hawkes (Executive Director, Golf and Health) at the World Golf Foundation;
Martin Slumbers (Chief Executive), Kevin Barker and Jackie Davidson (Director and Deputy Director, Golf Development) Ed Hodge (Communications) and Omar Malik (Golf Development) at the R&A;

Aston Ward (Director of Communications) and Ian Randell (Chief Executive), Professional Golf Association of Europe;

Anthony Scanlon (Chief Executive), Tony Bennett (Head of Inclusion), Patrick Schamasch (Chief Medical Officer), International Golf Federation;

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Key partners in collaborating to deliver impact from this research include the World Golf Foundation, The R&A, the European Tour, PGA's Europe, Paths for All, the Scottish Government, and the Westminster All-Party Parliamentary Group on Golf.

My family mean the world to me. My father Scott and brother Iain have shown patience, shared contacts and explained difficult concepts simply, my mother Mary provided optimism and support. My wife Jennie, children Nina, Francesca and Sonny put a smile on my face.

Word Count (to nearest 100 words)

Preface and abstract: 4200

Main text: 57,000 (Includes inserted PDF's of published papers, and tables and figures)

References: 6800

Appendices: 18,800.

Total 86,800

Abbreviations

APPG	All-Parliamentary Group on Golf (UK)
BBC	British Broadcasting Corporation
BMI	Body mass index
BMJ	British Medical Journal
BJSM	British Journal of Sports Medicine
CEO	Chief Executive Officer
CMO	Chief Medical Officer
CNN	Cable News Network
CVD	Cardiovascular disease
ET	European Tour Golf
EDGA	Formerly the European Tour Disabled Golf Association
GAPA	Global Advocacy for Physical Activity
GAPPA	Global Action Plan for Physical Activity
HEFCE	Higher Education Funding Council for England
HEPA	Health Enhancing Physical Activity
IOC	International Olympic Committee
IGF	International Golf Federation
ISPAH	International Society for Physical Activity and Health
MET	Metabolic Equivalents of Task
MSA	Muscle strengthening activity
MVPA	Moderate-to-vigorous physical activity
NBC	National Broadcasting Company (USA)
NHS	National Health Service (UK/ Scotland)
NCD	Non-communicable disease
PA	Physical Activity
PfA	Paths for All
PGA	Professional Golf Association
R&A.	Formally known as “Royal and Ancient”, The “R&A” is now the full used name
SB	Sedentary behaviour
SDG	Sustainable Development Goal
UK	United Kingdom
UN	United Nations
USA	United States of America
WGF	World Golf Foundation
WHO	World Health Organisation

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Chapter one: Overview, research background and definition of concepts

1.1 The rationale, vision and objectives of the thesis

1.1.1 Rationale for the thesis

Increasing physical activity (PA) is a major priority both nationally in Scotland (Burns & Murray, 2014; The Scottish Government, 2018), and internationally (World Health Organisation, 2014, 2019). “Sports systems and programs that promote ‘sport for all’ and encourage participation across the life span” is noted as one of the best investments for physical activity (Global Advocacy for Physical Activity, 2012).

Golf is a sport played by over 60 million people across the life span in over 2/3rds of countries worldwide (The R&A, 2015). Golf has the potential to be one of the key sporting activities to contribute to increasing physical activity. However, given current global levels of inactivity (Guthold, Stevens, Riley & Bull, 2018) and the low relative contribution of sport to overall PA levels (Strain, 2018) it is clear that more learning and understanding of how to utilise and implement golf for health is needed.

At a personal/professional level, having worked in the physical activity field both in national policy (Scottish Government- Physical Activity Champion) and voluntary sector (Ramblers Scotland- President), and having a working interest in golf, from 2013 onwards I began to be asked questions regarding golf by golfers, and by colleagues in public health including the then Chief Medical Officer for Scotland Sir Harry Burns. Specifically, these questions often focussed on the potential health benefits and dis-benefits of golf to people and populations.

On conducting a brief literature search in 2014, it was evident that there was an evidence gap regarding the associations between golf and health. Having commenced the work for this thesis in 2015, initial searches of SportDiscus and Google Scholar identified systematic reviews evaluating evidence for health benefits of specific sports, finding evidence of health benefits for cycling, running and football (Oja et al., 2011, 2015). These studies suggest ongoing research and evaluation of other sports’ contribution to health is needed. This initial search identified relevant reviews, each of which covered a narrow area in the subject of golf and health (Cabri, Sousa, Kots & Barreiros, 2009; McHardy, Pollard & Luo, 2006; Theriault & Lachance, 1998) namely musculoskeletal injuries. These conclude that lumbar spine, and elbow injuries are frequent amongst amateur golfers, while hand and wrist injuries and lumbar/ cervical region injuries are common amongst professional players, with overall incidence of injury moderate (Cabri et al., 2009). One review looked at broad health benefits of golf but did not provide any detail of methods utilised nor made any available when email

contact was attempted, with a potentially high risk of bias (Walker Research Group, 2011). Therefore, robust and in depth reviewing the evidence on the topic of golf and health was required.

1.1.2 Thesis Vision and Objectives

Based on the preliminary/ formative work for the thesis, the **vision** for this thesis was to contribute new knowledge regarding what is known about golf and health, which in turn can contribute to improved population health.

To achieve this vision, my **objectives** were to:

- a) Conduct a systematically conducted scoping review of the literature
- b) Conduct original research to address identified knowledge gaps (this included cross-sectional survey, and a Delphi study).
- c) Provide guidance to
 - i) Golfers/ potential golfers
 - ii) The golf industry/ facilities
 - iii) The scientific community
 - iv) Policy/ decision makers
- d) Evaluate the uptake, use and impact of the research conducted.

The vision, and objectives of this thesis are shown in Figure 2 below.

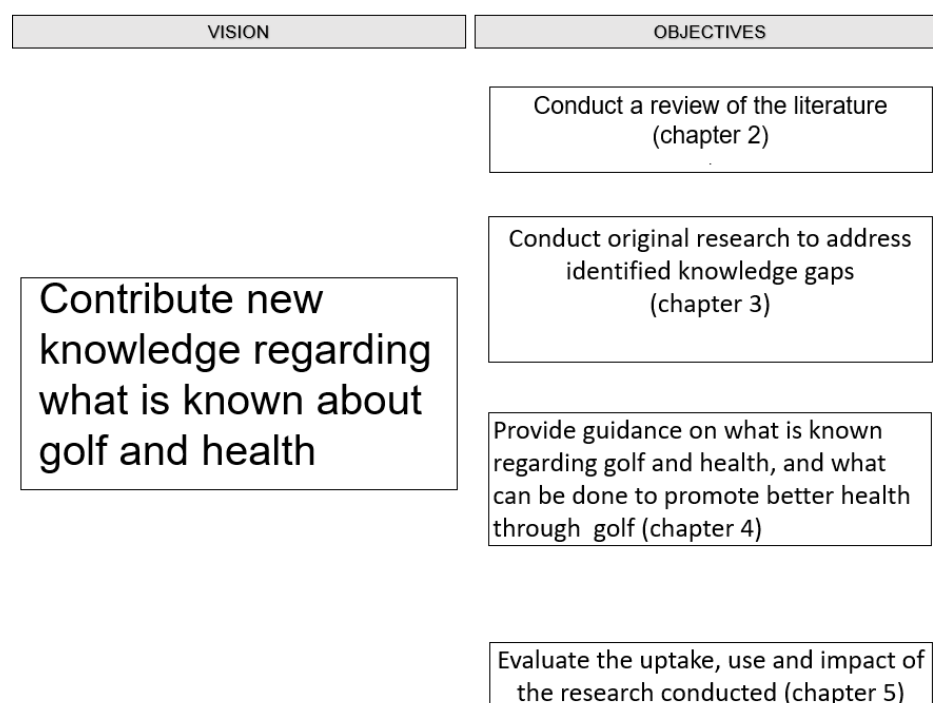


Figure 2. The vision and objectives for this thesis.

1.2 Health

In 1946 the World Health Organisation defined health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity” (World Health Organisation, 1946). However the last 20 years has seen a shift in understanding of the concept and the premises of health, moving from an idea of absence of disease to a wider appreciation of wellness, and an incorporation of the ability of people and populations to respond to physical, social and emotional challenges by adapting and self-managing (Huber et al., 2011; Leonardi, 2018).

The concept of health has also extended from a clear focus on human health to a planetary health model recognising the interconnections which human, ecosystem and environmental health have. Health is influenced by a range of individual behaviours and characteristics, and the physical, social, and economic environment that people are subject to, while behaviours may also be influenced by health (World Health Organisation, 2016).

1.3 Physical activity and health

1.3.1 What is physical activity?

The World Health Organisation (WHO) define physical activity as “any bodily movement produced by skeletal muscles that requires energy expenditure (World Health Organisation, 2010), a definition used unmodified in this thesis. The most recent UK Physical Activity Guidelines (Department of Health and Social Care, 2019) provide advice across a range of PA modalities namely

- i) Moderate-and-vigorous intensity physical activity (MVPA)
- ii) Minimisation of sedentary behaviour
- iii) Muscle strengthening PA, and
- iv) In older adults (65+ years) balance and co-ordination activities

1.3.2 Why does physical activity matter?

Regular physical activity has comprehensive health benefits for people of all ages, genders, geographical, cultural and socio-economic backgrounds (Department of Health and Social Care, 2019; Donaldson, 2004; United States Department of Health and Human Services, 2018; World Health Organisation, 2010). These benefits include decreased rates of premature mortality (Arem et al., 2015; Lee et al., 2012, Lim et al., 2012;), reduced incidence of breast and bowel cancer (Lee et al., 2012), risk of depression (Mammen et al., 2013; Schunch et al., 2016) and lower risk of dementia (Livingston et al., 2017). Improvements are also seen in cardio-metabolic health (LaMonte et al., 2017; Lee et al., 2012; Murtagh, Boreham, Nevill, Hare, Murphy, 2005,) brain health and function (Halloway, Wilbur, Schoeny & Arfanakis, 2016; Larson et al., 2006; Smith et al., 2017; Sofi et al., 2011).

Regular physical activity can deliver cost savings for local, national, and international policy makers providing health, well-being and productivity benefits (Bull et al., 2010; Lee et al., 2012; Kohl et al., 2012; World Health Organisation, 2019). These benefits can benefit individuals across their life-span, but also provide benefits to populations.

The World Health Organisation detail that policy action aimed at increasing physical activity can contribute towards attaining 13 of the 17 United Nations Sustainable Development Goals set for 2030 (Foster, Shilton, Westerman, Varney, & Bull, 2018; United Nations, 2015; World Health Organisation, 2019).

Evidence for the benefits of physical activity has been consistent and growing since being described as a “best buy” for public health since the mid-1990s (Morris, 1994).

Some forms of PA such as walking have multiple benefits not only for physical and mental health of the individual but for the health of the planet. The World Health Organisation director for Non-Communicable Diseases Prof Fiona Bull recently detailed that increasing physical activity and specifically activities that include walking could be considered a best buy not only for people, but for planetary health (Bull and Hardman, 2018).

1.3.3 *Global prevalence of physical inactivity*

Worldwide pooled analysis data including 1.9 million participants in 168 countries showed global age-standardised prevalence of insufficient PA to be 27.5% when incorporating 2001-2016 data (Guthold et al., 2018). There are significant variations in physical activity level dependent on age, gender, socio-economic status, ethnicity, geography, and disability (Guthold et al., 2018; Hallal et al., 2012a, World Health Organisation, 2013, 2019). PA was defined as “not doing at least 150 mins of moderate-intensity or 75 mins of vigorous-intensity physical activity per week, or any equivalent combination of the two”. The authors describe no significant change in prevalence of insufficient PA globally from 2001-2016 data.

The Lancet 2012 series on physical inactivity reflected

*“In view of the prevalence, global reach, and health effect of physical inactivity, the issue should be appropriately described as **pandemic**, with far-reaching health, economic, environmental, and social consequences”* (Kohl et al., 2012), while a 2016 follow up series noted an ever growing urgency for action (Das & Horton, 2016).

Physical inactivity has been identified as a major contributor to non-communicable disease (NCD) burden (Department of Health and Social Care, 2019; United States Department of Health and Human Services, 2018; World Health Organisation, 2018). Physical activity levels and the burden attributable to NCDs vary significantly worldwide (Guthold et al., 2018; Hallal et al., 2012a; Lee et al., 2012; Lim et al., 2012). The direct healthcare costs of physical inactivity are \$54 billion per year (Ding et al., 2016). Prevalence of insufficient PA is approximately twice as high in high income countries compared to low income, (Guthold et al., 2018), while older adults are generally less active than younger adults.

The 2013 World Health Assembly agreed a target of a 10% relative reduction in the prevalence of physical inactivity (judged by failure to reach Moderate to Vigorous Activity targets) by 2025 (WHO, 2013). Progress towards this is described in the World Health Organisation Global Action Plan as “slow and uneven” (WHO, 2019).

1.4 Golf, physical activity and health

The modern game of golf originated in 15th century Scotland (Geddes, 2007). Golf is a sport traditionally played on a large open-air course, in which a ball is struck by a club, with the aim of taking the lowest number of strikes possible to get the ball into (traditionally) 18 holes in the ground. The objective of golf is to get the golf ball into the holes in the lowest number of shots. Most commonly played as a round of 18 holes, golf can also be played over 9 holes, or practiced at driving ranges, putting greens and other golfing facilities. Courses and practice facilities can be of varied topography, varying in length, and terrain features. For the purpose of this thesis, I include all golf played on a course, driving range and other golf practice activities where a golf ball is struck by a club. I did not include frisbee golf, foot-golf or other activities that include aspects of golf, but do not involve striking a golf ball with a golf club.

Golf is played by around 55-60 million people (Farrally et al., 2003; The R&A, 2015) young and old, on 34,011 golf facilities in 206 of 239 countries worldwide (The R&A, 2015). Of these facilities, 71% are open to the public, while 79% of facilities are located in the top 10 golfing countries by absolute participation numbers. These are largely based in North America, Europe and Oceania (The R&A, 2015). Golf facilities are currently most prevalent in “developed” nations, with a population of 1210 per golf hole in Oceania, compared with 89,229 per golf hole in Africa. The R&A’s ‘Golf Around the World 2015’ report concludes that overall the influence and reach of the sport is growing, with a growth of the game in non-traditional markets, for example Belarus, Azerbaijan and Georgia opening their first facilities in 2013-14.

By the World Health Organisation definition golf as most often played meets this definition of physical activity. This includes both the act of striking the ball, and the associated movement (most often walking) around the playing area.

Given the established mortality, physical and mental health benefits, and economic savings from increasing physical activity, persons, practitioners and policy makers are increasingly interested in further researching the health effects and associations of particular forms of physical activity. Domains of physical activity include: work and occupation, active travel, housework and gardening, and leisure and recreation. Sport is commonly assumed to be a form of PA that could be utilised to increase physical activity, and for wider cultural benefits. Sport is promoted as a key potential contributor to increasing physical activity by Global Advocacy for Physical Activity in their ‘Best Investments’ guide (GAPA, 2012) and by the World Health Organisation in the Global Action Plan for Physical Activity (World Health

Organisation, 2019). However existing UK evidence suggests that sport is a minority contributor to overall physical activity, with walking, occupational and domestic activity providing a larger proportion of population based physical activity (Belanger, Townsend & Foster, 2011; Strain, Fitzsimons, Foster, Mutrie, Townsend & Kelly, 2016).

Not all sports are equal, and when it comes to policy and implementation. Information on the specific benefits of different sports is critical. As such, researchers have started to investigate this area. A 2015 systematic review looking at health benefits related to different sports suggested evidence was strongest for running and football, while ongoing evaluation looking at other sports was required (Oja et al., 2015). While Oja et al's review identified 69 eligible studies, only one reported the relationship between golf and health. This was a key part of the justification for work that sought to build the evidence base for golf, supporting the rationale for this thesis.

1.5 Supporting and evaluating the uptake, use and impact of research

This thesis was conceived not just to contribute knowledge, but to generate meaningful and impactful evidence and outputs that would contribute to improved health. This speaks to the broader context in academia where the dissemination of research, demonstration of uptake, use and impact beyond academia, and the building of relationships between researchers, end users and other stakeholders are increasingly recognised as key in building responsive research communities (Morton, 2015a,b; Ozanne et al., 2017; The UK Economic & Social Research Council, 2015). Assessment frameworks for funding increasingly prioritise the demonstration of impact for research (Higher Education Funding Council for England (HEFCE), 2014).

Researchers, including myself, have articulated the importance of focusing not only on conducting and publishing the research (Barton et al., 2017, Murray et al., 2019a) but also in sharing this research in an accessible form to the end user to stimulate impact. Whilst conducting this research, I followed the processes in Figure 3, reproduced with permission from Murray et al., 2019c.

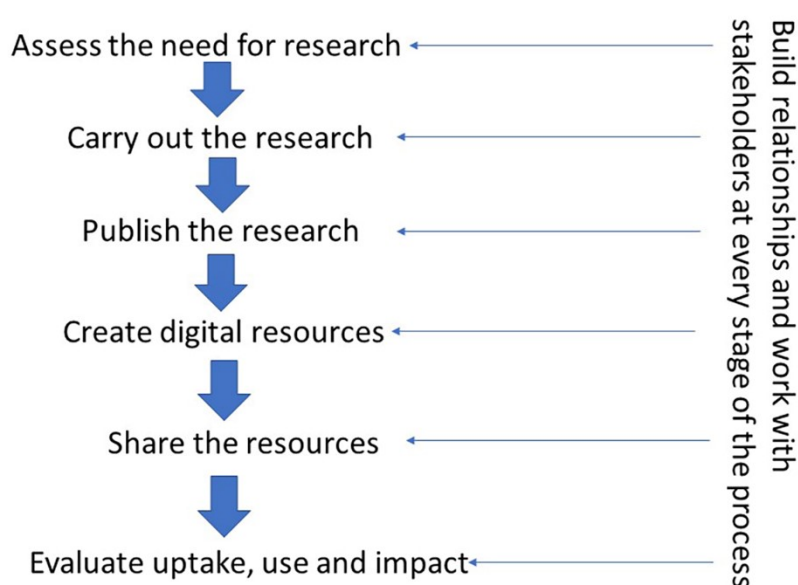


Figure 3. Research Impact Tool. Steps aimed at increasing the uptake, use and impact of research. Reproduced with permission, Murray, 2019, Br J Sports Med.

I aimed to facilitate the uptake, use and impact of this research, whether results showed positive, negative, or no associations between golf and health. I also wanted to measure and gain a sense of whether this use and impact for golf and health studies had been achieved, and needed a tool or framework to assist this. The Research Contribution

Framework (RCF) (Morton, 2015a,b) provides a practical approach used by universities for evaluating the uptake, use and impact of research. Therefore, it was also determined to assess the contribution of the research throughout the PhD to end-user groups using the RCF.

1.6 First steps for the thesis - a review of the literature

As identified when building the proposal for this thesis, a number of studies have assessed golf as a physical activity (Broman, Johnsson, & Kaijser, 2004; Murase, Kamei, & Hoshikawa, 1989) or assessed some aspect of its effects and relationships on health (Cabri et al., 2009; Farahmand, Broman, De Faire, Vågerö, & Ahlbom, 2009; Pakkari et al., 2000). These studies in general point towards positive associations between golf and longevity (Farahmand, Broman, De Faire, Vågerö, & Ahlbom, 2009), and cardiovascular risk factors (Pakkari et al., 2000; Palank & Hargreaves, 1990), while noting a moderate risk of injury. Many of these studies were not included in the 2015 systematic review looking at health benefits related to different sports (Oja et al; 2015) which had strict inclusion/ exclusion criteria, that excluded a wider breadth of study that may have relevant information. This study (Oja et al., 2015) used restricted search terms, and inclusion criteria that would seem to exclude important studies in a variety of sports including golf, with for example very little attention to evidence related to mental health and well-being.

No study has systematically reviewed the literature regarding golf and health and provided a 'big picture' view evaluating the relationships between golf and physical/ mental health. Therefore, this was the objective for the first study of my PhD (see Figure 2). The Scoping Review (Murray et al., 2017b) is presented in chapter two.

1.7 Chapter summary and overview of the structure of this thesis

This introductory chapter outlines the rationale for study into golf and health, based on the importance of PA, the popularity of golf around the world, and knowledge gaps in the area. It presents the (preliminary) vision and objectives that stem from this rationale and the plan for the thesis. It justifies conducting a Scoping Review as the first study.

This thesis consists of six main chapters, followed by references and appendices sections. This first chapter explains the vision and objectives of the thesis, defines health, and discusses how it can be influenced by physical activity.

Chapter two (scoping review) provides the necessary review of relevant literature, identifying evidence on golf and health and also future research priorities. Chapters 3-5 outline work conducted in response to the review findings.

The scoping review identified a knowledge gap, which has been addressed in chapter three, assessing golf spectators' beliefs and self-reported physical activity during, and 3 months after they attended a professional golf tournament in the UK.

Chapter four presents an international consensus on golf and health, built using modified Delphi methods to guide action by people, policymakers and the golf industry to improve health for people and populations. A description of methods to increase research impact and a contributions analysis, evaluating the uptake, use and impact of the scoping review, spectator health, and consensus forms chapter five.

Chapters two, three, four and five are all based on research published in peer-reviewed journals and contain the relevant journal articles, with references in the style of the publishing journal. To accompany the published manuscript, an introduction and further discussion is provided in each of these chapters.

An overall thesis discussion, comprising principal findings, exploration of major themes, comparison to previous work, future direction of study, the strengths and limitations of the thesis and conclusions are outlined in chapter six, while a full reference list presented in the APA format stipulated by the University of Edinburgh, and appendices section are also provided.

Chapter Two: Scoping review

2.1 Introduction

2.1.1 Rationale and background

As outlined in Chapter 1, the **objective** for the first study was to conduct a methodologically rigorous review in order to understand the relationships between golf and health, mapping and summarising the evidence, and identifying significant gaps in the literature.

The objectives and research questions for the literature review are shown in Figure 4.

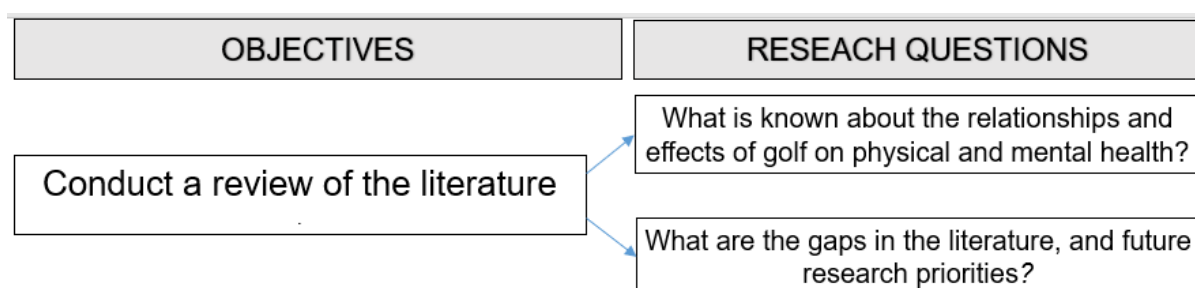


Figure 4. Objectives and broad research questions for literature review.

This chapter outlines the rationale for choosing to conduct a scoping review, and the methodological frameworks.

I then present three outputs relating to the scoping review assessing the relationships between golf and health. These papers were all published in the British Journal of Sports Medicine (BJSM). These comprise

- The scoping review protocol (Murray et al., 2016b)
Murray, A., Daines, L., Archibald, D., Hawkes, R., Grant, L., & Mutrie, N. (2016). The relationship and effects of golf on physical and mental health: a scoping review protocol. *Br J Sports Med*, 50(11), 647-650.
- The scoping review (Murray et al., 2017b)
Murray, A. D., Daines, L., Archibald, D., Hawkes, R. A., Schiphorst, C., Kelly, P., ... & Mutrie, N. (2017). The relationships between golf and health: a scoping review. *Br J Sports Med*, 51(1), 12-19.
- An infographic providing a visual summary of this work (Murray et al., 2017a)
Murray, A. D., Daines, L., Archibald, D., Hawkes, R. A., Schiphorst, C., Kelly, P., ... & Mutrie, N. (2017). Infographic. Golf and health. *Br J Sports Med*. Online first.

Strict word limits imposed by the BJSM do not permit as thorough discussion as is merited for the purpose of a thesis, so further exploration, including an introduction, discussion of the

principal findings, strengths and limitations, context and the approach taken to ensure maximal research use, research uptake, and research impact are presented here in addition to the published manuscript. Some repetition has been needed to include published studies in full, while maintaining coherence for the thesis.

2.1.2 Author contribution

I conceived the study and identified the research question. Following this I evaluated studies against eligibility criteria and extracted data from included studies. I collated, summarised and reported the results. I led the writing of all manuscripts, further developing them with input from supervisors and colleagues prior to submission. I worked with the existing literature to develop a strategy to maximise uptake, use and impact of studies, including engagement with key stakeholders, and the production of communication assets for example infographic, video, podcast and press release.

Professor Nanette Mutrie, Professor Liz Grant and latterly Dr Paul Kelly provided guidance in the development of methods and the conduct of the scoping review. Dr Daryll Archibald provided additional input regarding methods given his experience conducting scoping reviews in a range of health contexts, while University of Edinburgh senior librarian Marshall Dozier assisted during the search strategy phase. Dr Luke Daines provided secondary support in study selection and data extraction which is necessary to conduct a robust scoping review. For each paper, all authors helped develop, review, and approve final manuscripts. Chloe Schiphorst assisted with the design of the infographic.

2.1.3 Why a Scoping Review?

What was required was a methodological framework that would allow me to i) map the key concepts and evidence, ii) summarise existing research findings and iii) identify gaps in the existing research. My preliminary searches and work indicated the need for a broad evaluation of the evidence base, finding a growth in empirical work, but a lack of review level evidence.

Systematic reviews are widely used to inform practice and policy, evaluating the best available evidence, and evaluating the quality of evidence. I initially considered a systematic review and other types of reviews but recognised the research question/s were broad, and the evidence heterogenous. Scoping reviews are designed to provide an inclusive overview of available evidence on a broad topic and identify knowledge gaps (Tricco et al., 2018).

There are many methods available for reviewing literature, of which scoping reviews are just one. While systematic reviews assess relatively narrow, clearly defined research questions

(Arksey and O'Malley, 2005), my priorities were to map the key concepts and evidence around a broad area (golf and health), identify research gaps, to inform the conduct of original research in priority areas.

Thus the necessity to use a framework collating and summarising information on a broad topic was the key factor in a scoping review being the best option for providing an overview of available evidence. The other leading consideration was ensuring clear, robust and reproducible methods. Although research has highlighted shortfalls in the terminology, definitions and methods of many published scoping reviews (Colquhoun et al., 2014; Tricco et al., 2016), best practice methodological frameworks are available which would serve as our guide (Arksey and O'Malley, 2005; Levac, Colquhoun, & O'Brien, 2010; Peters et al., 2015).

2.2 Frameworks for scoping reviews, and published protocol

Robust scoping review frameworks exist (Arksey & O'Malley, 2005; Levac, Colquhoun, & O'Brien, 2010; Peters et al., 2015) to aid clarity and rigour in conducting these reviews. I adopted these processes and in keeping with this produced a scoping review protocol thus predefining methods and objectives. This was particularly important given the declared conflicts of interest, and to minimise any risk of selective reporting.

“The relationships and effects of golf on physical and mental health: a scoping review protocol” was published by BMJ publishing in the British Journal of Sports Medicine in April 2016. Permission to publish this article as an appendix within this thesis is granted under the Creative Commons Attribution License (CC BY 4.0; <https://creativecommons.org/licenses/by/4.0/>).

The full article is presented as Appendix 4 in this thesis, and at the online link that follows <http://bjsm.bmj.com/content/50/11/647.full>

2.3 Scoping review- the relationships between golf and health

Methods described in the protocol enabled the production of “the relationships between golf and health: a scoping review” (Murray et al., 2017b), published in the British Journal of Sports Medicine.

Further supplementary files, published online only with the scoping review are presented in the Appendix to this thesis, as below:

Appendix 5 Scoping review, supplementary file one. Background information.

Appendix 6 Scoping review. Supplementary file two. Full search strategy

Appendix 7 Scoping review. Supplementary file two. Data extraction form

In the time between the publication of the scoping review (online first 2016), and the write up of this thesis (2019/2020), the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) checklist was published (Tricco et al., 2018). This drew on publications from the EQUATOR (Enhancing the QUALity and Transparency of health Research) network (EQUATOR, 2009). A retrospectively completed checklist for the golf and health scoping review is found at Appendix 8 -PRISMA-ScR checklist for “the relationships between golf and health: a scoping review”.

Permission to publish the scoping review and supplementary files within this thesis is granted under the Creative Commons Attribution License (CC BY 4.0;

<https://creativecommons.org/licenses/by/4.0/>). A link to the article is shown below.

- a) The relationships between golf and health: a scoping review

<http://bjsm.bmj.com/content/51/1/12.full?sid=ae7b40a2-1912-4388-b11b-88635bce8e63>

The full article is presented below



OPEN ACCESS

The relationships between golf and health: a scoping review

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► Additional material is published online only. To view please visit the journal online (<http://dx.doi.org/10.1136/bjsports-2016-096625>).

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ABSTRACT

Objective To assess the relationships between golf and health.

Design Scoping review.

Data sources Published and unpublished reports of any age or language, identified by searching electronic databases, platforms, reference lists, websites and from consulting experts.

Review methods A 3-step search strategy identified relevant published primary and secondary studies as well as grey literature. Identified studies were screened for final inclusion. Data were extracted using a standardised tool, to form (1) a descriptive analysis and (2) a thematic summary.

Results and discussion 4944 records were identified with an initial search. 301 studies met criteria for the scoping review. Golf can provide moderate intensity physical activity and is associated with physical health benefits that include improved cardiovascular, respiratory and metabolic profiles, and improved wellness. There is limited evidence related to golf and mental health. The incidence of golfing injury is moderate, with back injuries the most frequent. Accidental head injuries are rare, but can have serious consequences.

Conclusions Practitioners and policymakers can be encouraged to support more people to play golf, due to associated improved physical health and mental well-being, and a potential contribution to increased life expectancy. Injuries and illnesses associated with golf have been identified, and risk reduction strategies are warranted. Further research priorities include systematic reviews to further explore the cause and effect nature of the relationships described. Research characterising golf's contribution to muscular strengthening, balance and falls prevention as well as further assessing the associations and effects between golf and mental health are also indicated.

INTRODUCTION

The objective of this scoping review is to map the literature on golf and health and to examine the relationships and effects of golf on physical and mental health.

Golf is a sport usually played on a large open-air course, in which a ball is struck with a club, with the aim of taking the lowest number of shots possible to get the ball into a series of holes in the ground. Golf is played by around 55 million people¹ in 206 countries worldwide² representing 1/127 of the global population. This global reach, and appeal to persons of all ages and abilities has seen golf reintroduced in 2016 to the Olympic Games, with efforts ongoing to secure Paralympic

status for disability golf. Further information about golf is shown in online supplementary appendix 1.

Health is influenced by a range of individual behaviours and characteristics, and the physical, social and economic environment that people are subject to.³ There is compelling evidence that regular physical activity has longevity, physical and mental health benefits for people of all ages, genders, geographical and socioeconomic backgrounds, and can deliver economic benefits for communities, as well as national and international policymakers.^{4–6}

Golf has potential to provide physical activity, and thus health and social benefits to persons of all ages. Golf is particularly popular among middle-aged and older adults, who are generally less active than younger adults.^{7 8} To date the review evidence on this topic is limited. Previous reviews,^{9 10} including a systematic review,¹¹ have been undertaken to consider the relationships between golf and health with many of these focusing on the subject of golf-related injuries, while a further review of undocumented methodology¹² focused on health benefits only. A recent systematic review of health benefits related to sport suggested that evidence was conclusive only for football (soccer) and running, noting further evaluation and research looking at other sports, including golf, was required.¹³ A clear need exists to comprehensively review the relationships between golf and health. We therefore undertook a scoping review that maps available evidence, in order to identify the existing gaps in evidence and document impacts of golf on health where these data were available.

METHODS

We adopted the established five-stage scoping review process proposed by Arksey and O'Malley, incorporating adaptations from Levac *et al*, and the Joanna Briggs Institute^{14–16} as per our published protocol.¹⁷ The following summarises our approach to each stage.

Stage 1: Identify the research question

Considering the populations, concepts and contexts of interest enabled a broad research question to be formulated:

What is known about the relationships and effects of golf on physical and mental health?

Stage 2: Identifying relevant studies

The following explicit inclusion and exclusion criteria were developed through researcher discussion and expert consultation:

Inclusion criteria:

- ▶ Research articles not limited by geographical location, language or setting.
- ▶ All age groups and both sexes of participants.
- ▶ Research that considers the general population, as well as specific population groups (with a specific physical or mental illness or condition).
- ▶ All forms of golf (including but not limited to 18 holes, 9 holes, driving range, spectating).
- ▶ Any physical and/or mental health condition.
- ▶ Sources of information, including primary research studies, reviews, systematic reviews, scoping reviews, meta-analyses, guidelines, as well as grey literature to include unpublished and ongoing trials, annual reports, dissertations and conference proceedings.

Exclusion criteria:

- ▶ Opinion pieces/opinions, magazine and newspaper articles, case reports, papers with no data.
- ▶ Health and safety/occupational issues not related to playing or watching golf.
- ▶ Studies focusing on biomechanics, or improved performance in golf.

Search strategies and databases**Step 1: An initial limited search**

An initial limited search (September 2015) of SPORTDiscus and Google Advanced Search for review articles and ProQuest for dissertations was conducted as detailed in the published protocol.¹⁷

Step 2: Identify key words and index terms

The title, abstract and index terms used to describe the articles identified in step 1 were analysed. The research team identified golf as the only primary research term. For the health-focused databases, namely MEDLINE and PsycINFO, 'golf' was used as the only search term to maximise inclusivity. Secondary search terms included a broader set of keywords for SPORTDiscus, Web of Science and Google Scholar. Boolean terms AND and OR were used to extract relevant studies. All relevant articles from SPORTDiscus and Web of Science were reviewed, with the same search strategy applying to Google Scholar. A pragmatic decision to review only the Google Scholar articles with these terms in the title was taken following consultation with a research librarian.

A similar strategy was applied to the grey literature. The same search terms used for SPORTDiscus, Web of Science and Google Scholar were applied to search for theses in the ProQuest database. 'Golf' as the only search term was used for the WHO International Clinical Trials Registry Platform. The advanced search function on Google was used to look for relevant reports and articles from the World Golf Foundation, the Royal and Ancient, the *British Journal of Sports Medicine*, The American College of Sports Medicine and the Faculty of Sports and Exercise Medicine while representatives of these organisations were contacted for further information.

Step 3: Further searching of references and citations

A search was conducted of the reference list of the most relevant identified articles while authors of relevant primary comprehensive, scoping or systematic reviews were contacted for further information.

The complete final search strategy is shown in online supplementary appendix 2.

Stage 3: Study selection

Relevant titles and abstracts were evaluated against the eligibility criteria by one reviewer (ADM). A second reviewer (LD) completed the same process on a random sample of 10% of titles and abstracts, with concordance >97% regarding inclusion/exclusion decision. Where a consensus was not reached, the study proceeded to full-text review.

Scoping reviews are typically iterative, as reviewers become increasingly familiar with the research and evidence.¹⁴ We wished to focus on the relationships and effects of golf on physical and mental health. To enhance this focus, 'studies focusing on biomechanics, or improved performance in golf' was added to the existing exclusion criteria stated in the scoping review protocol.¹⁷

Full-text articles meeting the inclusion criteria were sourced. Translations by University staff and associates who were fluent speakers of Chinese, French, German, Italian, Japanese, Korean, Spanish and Thai to English were undertaken. Despite searching the University of Edinburgh library databases, using interlibrary loans and contacting authors, 3^{18–20} of 365 papers could not be found and were excluded.

Stage 4: Charting the data**Extracting the results**

Charting tables to record and assimilate extracted data from included studies were developed. *A priori* categories were charted as were emergent themes. Three reviewers (ADM, LD and EJ) undertook data extraction duties. A sample data extraction form is shown in online supplementary appendix 3. ADM extracted data from 90% of included studies and LD/EJ extracted data from 10% of studies. LD/EJ checked 10% of ADM's data extractions for accuracy and vice versa. Any discrepancies were discussed at group meetings. Concordance was >97% regarding inclusion/exclusion.

Data extraction categories

- A. Author(s).
- B. Year of publication.
- C. Origin (where the study was published/conducted).
- D. Aims/purpose.
- E. Study population and sample size (if applicable).
- F. Methodology/methods.
- G. Intervention type, comparator, details of these.
- H. Duration of the intervention.
- I. Outcomes and details of these (eg, how measured).
- J. Key findings that relate to the scoping review research questions.

Stage 5: Collating, summarising and reporting the results

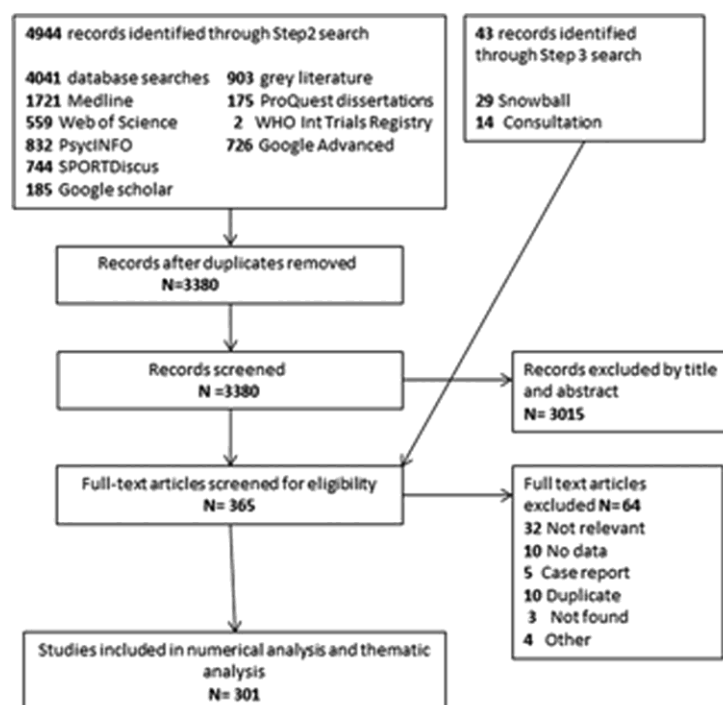
Methods employed in the protocol¹⁷ enabled us to collate existing knowledge on this broad topic and summarise and report as

1. A descriptive analysis, mapping the data, showing distribution of studies by period of publication, country of origin, study method and theme/focus.
2. A thematic summary, describing how identified research relates to the research question and aims, and the main findings from these organised by theme.

In this study, we aim to:

- A. Map the evidence and key concepts available for golf and health.
- B. Summarise and share existing research findings in a useful way for policymakers, practitioners and other relevant stakeholders.
- C. Identify research gaps in the existing literature on golf and health.

Figure 1 Scoping review flow chart.



RESULTS AND DISCUSSION

Descriptive analysis

A review flow diagram (see [figure 1](#)) details the results from the search, and study selection processes.

Our initial search identified 4944 studies. Of these, 4041 were identified searching databases/search platforms, and 903 from grey literature. After duplicates were excluded, 3380 records remained. A further 43 eligible studies were identified by snowballing or via expert consultation during the step 3 search.

In total, 362 articles underwent full-text screening, 3015 records being excluded after abstract screening with a further 3 articles excluded as full text was unavailable.

Overall, the scoping review identified 301 eligible studies relevant to the aims and research question ‘What is known about the relationships and effects of golf on physical and mental health?’ and these are included in the analysis.

Included studies by year of publication

In keeping with wider bibliometric trends in sport and health research, [figure 2](#) highlights a substantial chronological increase in the number of papers relating to golf and health, with an associated increase in the range of study designs and research questions.

Geography of included studies

Research studies were identified from 24 countries and in 9 languages. [Table 1](#) demonstrates the percentage of included studies per country. The majority (53.8%) of included studies were from the USA, where almost half of the world’s golfers live.² Studies from North America (57.1%), Europe (22.3%) and Oceania (10.0%) are relatively well represented, as they are

generally for research publications on physical activity.²¹ There were fewer included studies per golfing facility (eg, golf course, driving range and practice facilities) from Asia (10.0%) and Africa (0.3%), and none included from South America.

Type of study

Study design

The studies varied considerably in terms of study design and primary focus. No formal quality assessment of included studies was performed as scoping reviews are intended to provide a map of what evidence has been produced as opposed to seeking only the best available evidence to answer a narrow policy or practice-related question.¹⁵ A taxonomy of research designs included by the scoping review is shown in [figure 3](#).

One hundred and seventy-eight (59.1%) were primary research, while 89 (29.5%) were secondary studies and 34 (11.3%) were grey literature.

Of the primary literature, 118 (66.3%) studies had a cross-sectional design, with 14 (7.9%) longitudinal and 46 (25.8%) experimental. The majority of the experimental studies quantified golf parameters, for example, steps taken or calories burned while playing golf. Overall 16 of 301 studies conducted a primary assessment of health outcomes in relation to golf, while only 4 conducted interventions principally aiming to promote behaviour change in relation to golf and health.

The vast majority of secondary studies were reviews. Only six of these were systematic reviews. The systematic reviews each focused on a narrow aspect of the broad topic of golf and health.

The grey literature comprised 17 published conference proceedings, 11 theses and 6 organisational reports.

Figure 2 Included studies by year of publication.

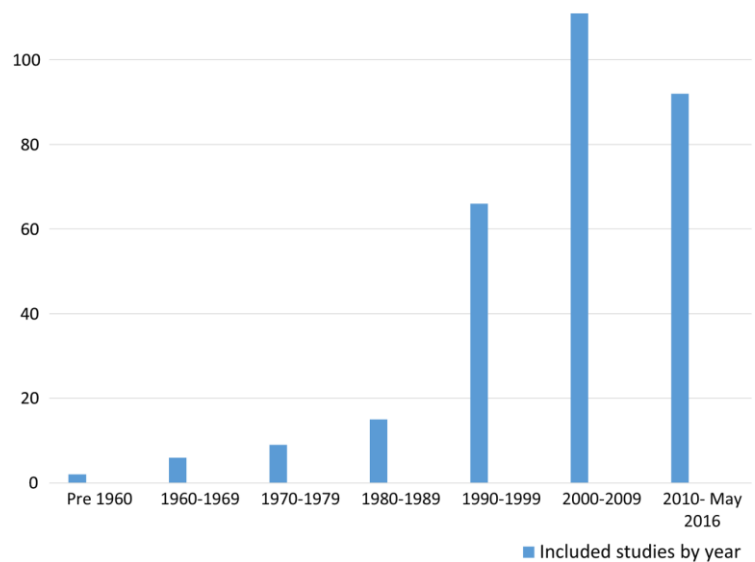


Table 1 Geography of included studies

Country	No. of studies	Percentage of studies
USA	162	53.8
UK	38	12.6
Australia	27	9.0
Japan	12	4.0
Canada	10	3.3
South Korea	10	3.3
Germany	8	2.7
China	4	1.3
Sweden, Norway, New Zealand, Switzerland, Spain, France	3 each	1.0 each
Finland, Austria, Thailand	2 each	0.7 each
India, Singapore, the Netherlands, South Africa, Italy	1 each	0.3 each
All	301	99.9

Theme of the study

The primary focus of the included studies fitted broadly into four key themes, namely

1. Physical activity and golf (N=49).
2. Golf and physical health (non-injury/accident) (N=49).
3. Golf and injury/accident (N=135).
4. Golf and mental health/wellness (N=29).

These themes were formed from merging of the *a priori* categories identified. Additional studies from emergent themes were classified into a further category 'other and general' (N=39) to include studies of golf participation, implications for policy, legal implications or studies that focus evenly on more than one of these areas. Articles focusing on injuries and accidents relating to golf were the most frequent, comprising nearly 44.9% of included studies despite the exclusion of articles with a biomechanical/performance focus. Figure 4 shows the primary focus of included studies.

THEMATIC SUMMARY

Key concepts and evidence available

Participation

Golf is a sport played by 55 million people in 206 countries, by males and females across the life-course.^{1,2} Globally, this compares to 250 million direct participants in football (soccer),²² 75 million tennis²³ and 5 million rugby union players.²⁴ Gaining health benefits and exercise are powerful motivators for persons to play sport, and golf in particular.²⁵⁻²⁷ Golfers more frequently continue to play into middle age compared with participants in sports like football and rugby.^{28,29} Golf is played by people of all backgrounds, but participation is stronger in males,^{8,30} higher socioeconomic groups⁷ and more affluent countries.²

Golf and physical activity

Golf can contribute to physical activity as a leisure time or recreational activity, while work and occupation yields physical activity for modest numbers of professional players and caddies.³¹

The relative contribution of golf to population physical activity increases in older adults,^{27,31} a group that are typically less physically active than younger adults,³² but for all ages remains considerably less than recreational walking, which is highly accessible and often bears zero cost.³¹

Individual differences in energy expenditure can be large, depending on individual and golf-related factors, but golf can provide moderate intensity physical activity. Moderate intensity physical activity is recommended for children, adults and older adults for the longevity, physical and mental health effects it brings.³³⁻³⁵ Golf typically involves a mixture of exercise intensities. Golf can help persons and populations meet, and exceed minimum health and government recommendations for Moderate to Vigorous Physical Activity.^{36,37}

Studies quantifying golf by Metabolic Equivalent of Task (MET) value generally agree it offers moderate intensity aerobic activity,^{36,38-46} although with a wide range of MET values quoted (2.5-8.0) some studies classify it as low intensity^{47,48} or high intensity.^{49,50} The mean of the range of estimates is 4.5 METs. Figure 5 shows MET values attributed to different

Figure 3 Taxonomy of research designs for included literature.

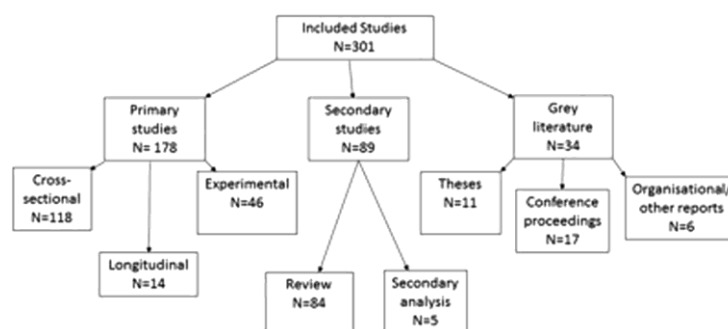
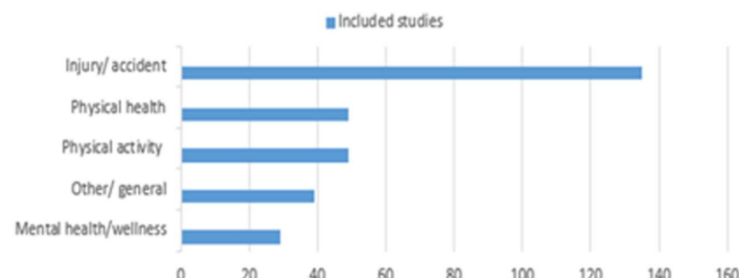


Figure 4 Primary focus of included studies.



modes of golf and, for comparison, other physical activities suitable for all ages, by the Compendium of Physical Activity.³⁸

Studies assessing calorie expenditure during golf typically classify golf as a moderate intensity physical activity with energy expenditure of 3.3–8.15 kcal/min,^{41–42, 51–56} 264–450 kcal/hour^{51–52, 56} and a total energy expenditure of 531–2467 kcal/18 holes.^{36–42, 43–49, 51–53, 56–59} Golfers walking 18 holes take between 11 245 and 16 667^{36–49, 60–61} steps, walking 4–8 miles,^{36–48, 49–51, 57–60, 62} while those playing and riding a golf cart accrue 6280 steps⁶¹ or just under 4 miles.⁵¹ There is poor agreement in the literature assessing intensity of golf by heart rate, with a majority classifying golf as low intensity,^{47–58, 63–65} but others quantifying it as moderate to high intensity.^{36–57, 66–67}

Intensity of physical activity playing golf is higher for those walking rather than riding a golf cart,^{51–58, 59, 63–68} those playing a hillier course,^{55–67} older adults,⁶⁶ heavier players,^{49–56, 69} males³⁶ and those of low baseline fitness. Intensity further varies depending if a player is swinging a club, walking or standing.⁶⁹

Knowledge of the contribution of golf to muscle strengthening and to the balance aspects of physical activity recommendations is limited, and a priority for a review and further primary research. Studies suggest that golf may improve proprioception, balance, muscle endurance and function particularly in the elderly,^{57–70–74} while in younger players, no increase in muscle mass or bone mineral density has been seen.⁷⁵

Sedentary behaviour is characterised as ‘any waking activity characterised by an energy expenditure over 1.5 METs and a sitting or reclining posture’.⁷⁶ Time playing golf without riding a golf cart is non-sedentary time,^{36–38–45, 47–49} and although golfers riding a golf cart do gain some health-enhancing physical activity, golfers walking the course gain more.

Unlike most other sports, golf spectating offers the opportunity to walk around the field of play, rather than being restricted to a seat. Spectators from North America and South Korea have highlighted ‘exercise’ as a reason for attending golf events, which can attract in excess of 500 000 spectators per week.^{77–79}

Golf and longevity

Physical inactivity is a determinant of excess mortality, killing >3 million,⁵ and perhaps in excess of 5 million people annually.⁴ The 2010 Global Burden of Disease study highlights that physical inactivity is one of the top five causes of death in North America, Western Europe and in Australasia,⁵ three regions where golf is frequently played.²

The best available evidence suggests that playing golf may contribute to reduced mortality and increased life expectancy. When a Swedish study compared 300 818 golfers to non-golfers, they found a 40% lower mortality rate, although the study design and limitations meant that this could not be directly attributed to golf-related physical activity.⁸⁰ The authors of that study speculate that this corresponds to a 5-year increase in life expectancy regardless of gender, age or socioeconomic status. This increase will also have further contributing factors, including other lifestyle factors. Playing sport several times per week is likely to benefit health more than playing one to two times per week.⁸¹ An association, but not causal relationship, is demonstrated between golf and life expectancy in Swedish and US studies.^{80–82}

Golf and physical health

In providing moderate intensity physical activity, it is biologically plausible that golf could be expected to have beneficial effects in the prevention and treatment of chronic diseases, including ischaemic heart disease, type 2 diabetes, stroke, and colon and breast cancer.^{4–83} A review commissioned by the World Golf Foundation concluded that participating in golf can ‘yield a number of positive health and fitness effects’¹² although methods were not stated and only health benefits were described. Frequent golfers perceive their physical health to be better than infrequent golfers.⁸⁴

Cardiovascular system

Golf is associated with improvements in known risk factors for cardiovascular disease, including physical inactivity,³⁸ blood

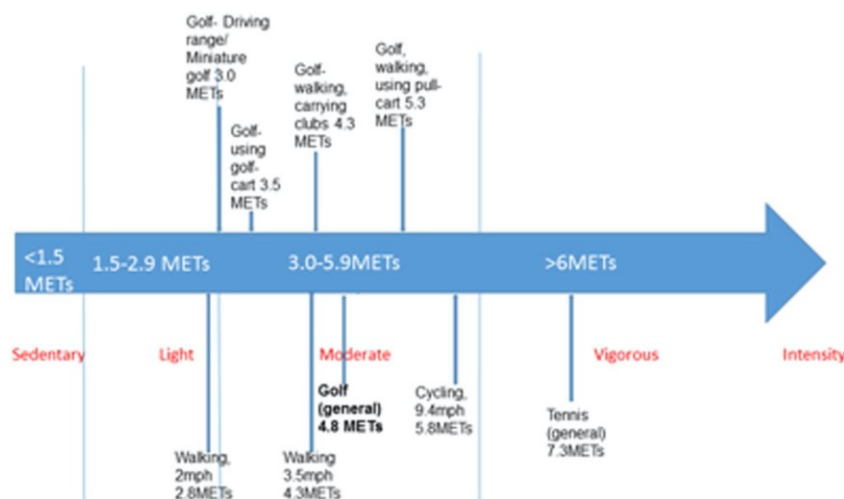


Figure 5 MET values attributed to different modes of golf and other physical activities. MET, Metabolic Equivalent of Task.

lipid and insulin–glucose levels,^{57 66 85} body composition^{57 85} and aerobic fitness,⁵⁷ although direct evidence and longitudinal trials assessing the medium-term and long-term impact of golf on coronary heart disease or cerebrovascular disease are lacking. Golf is reported as providing suitable exercise for patients with cardiac^{43 86 87} and stroke rehabilitation.⁸⁸

Golf can provide a sufficient stimulus to improve aerobic fitness, but higher intensity exercise generates significantly improved cardiovascular adaption compared to playing golf.^{43 57 69} The effects of a season of golf on systolic blood pressure showed no significant difference in a controlled trial,⁵⁷ while no consistent effect has been found measuring blood pressure during golf.^{64 67 86}

There is an increased incidence of acute cardiac events during participation in sport⁸⁹ and golf in particular.^{90–92} Golf players with new or unstable cardiac symptoms should consult a doctor.⁹⁰ There is contradictory and inconclusive evidence regarding the effectiveness and cost-effectiveness of automatic external defibrillators situated at golf courses.^{93–96} An extremely rare mechanism of ischaemic stroke linked to golf has been described.⁹⁷

Respiratory system

Regular participation in golf may improve lung function and maintain it in older adults.^{69 98} Separate golf and swimming interventions decreased hospital admission rates and symptom severity, while improving quality of life and parent satisfaction in a randomised trial of children with asthma.⁹⁹

Metabolic health

Quasi-experimental studies are united in describing overall positive effects on lipid profile.^{53 57 67 85} Statistically significant effects of a season of golf on body composition (body weight, body mass index, waist-to-hip ratio and some skinfold thicknesses) are described in controlled trials,^{57 85} while a smaller study showed no effect on body composition.⁶⁹ Blood glucose levels decreased during golfing activity in Swedish and Japanese studies.^{53 66}

Cancer risk

An inverse relationship is demonstrated regarding physical activity and colon/breast cancer.⁴ Five ultraviolet radiation dosimetry

studies report exposures that place golfers at higher risk of skin cancer than non-golfers.^{100–104} A cross-sectional study of female professional and amateur golf players highlighted increased numbers of non-melanoma skin cancers.¹⁰⁵ Appropriate sun-screen, protective clothing and shade availability are suggested.^{100 106}

Musculoskeletal health

Golf is associated with musculoskeletal benefits as well as accident and injury. Older golfers may gain improved balance,^{70 71 73} muscular function⁷² and strength⁷⁴ compared to controls, but no lower limb bone mineral density increase was found in male professional golfers.⁷⁵ Female caddies show better bone health than the general female population.^{107 108}

Golf and injury

Injuries and accidents related to golf comprise the largest group of studies identified by the scoping review. A 2009 systematic review and other reviews describe golf as overall a moderate risk activity for injury compared to other sports.^{11 26}

Prospective and retrospective epidemiological studies quote the incidence of injury in amateur golfers annually to be between 15.8% and 40.9%^{109–114} and lifetime injury incidence between 25.2% and 67.4%.^{10 115–118} Prospective longitudinal studies report very low injury rates compared to other sports, at 0.28–0.60 injuries per 1000 hours in amateurs.^{57 109 119} Professionals play more, and are injured more frequently, with annual injury rates of between 31.0% and 90.0%,^{115 120} and quoted lifetime incidence of 60.0–88.5%. Overall, the incidence of injury is moderate, and the rate of injury per hour played is low.

The most frequent cause of injury in amateur and professional golfers is volume of repetitive practice,^{113 114 116 117 121} while suboptimal swing biomechanics are a frequent^{115–117 122} and perhaps even leading¹⁰⁹ cause in amateurs. Attention to these factors, and to an adequate warm up,^{26 123–128} and physical conditioning^{11 26 129 130} reduces risk of injury.

Regarding limb injuries, the lead side (the left arm and leg in a right-handed golfer) is more often injured than the trail (right side in a right-handed golfer).^{11 26 113 131 132} The mean length of missed practice or competition quoted is 4.0–5.2 weeks.^{116 117} The spine and particularly the lower back

account for the greatest overall incidence of injury in amateur golfers (18.3–36.4%).^{109 115–117 133} The elbow (8.0–33.0%), the wrist and hand (10.0–32%) and shoulder (4.0–18.6%) are other frequently injured anatomical regions in amateur golfers.^{10 11 109 110 115–117 133}

Golf is an infrequent cause of head and particularly ocular injury, but these injuries can be severe particularly in children.^{134–145} Injuries in children most often occur when struck by a club,^{134 140–142} while adults are more frequently hit by a ball. Most paediatric golf-related injuries occur away from a golf course^{134 143} with authors urging preventative strategies targeting improved education and supervision of children and safe storage of golf equipment.^{11 134 135 138 140}

Although still infrequent, golf is reported to be the sport with the highest incidence of lightning strike in the USA¹⁴⁶ with deaths,^{147 148} and prevention strategies for players and courses outlined.¹⁴⁷

Golf cart-related injuries, including from falls, collisions or limb entrapment, can occur^{11 149 150} and can be severe.^{139 149–152} The US National Safety Council reports over 15 000 golf cart-related injuries per year, noting that not all are related to golf.¹⁴⁹ Authors suggest regulation and instruction around safe golf cart use,^{150 151} as well as improvement and standardisation of safety features—for example, speed limiters, seat belts and front wheel brakes.^{149 150}

Golf and mental health/wellness

No consistent evidence for the associations or effects of golf on mental illness was reported. Golf is associated with positive impacts on mental wellness.^{35 153 154} A wide range of methodologies, including qualitative interviewing, cross-sectional surveys and longitudinal studies, were used.

Mental health

A small experimental study enrolling nine persons with severe and enduring mental illness tentatively reported a number of mental and social benefits for participants.¹⁵⁵ There is conflicting evidence relating to the effect of golf and other sports on mood and anxiety, with positive¹⁵⁶ and negative⁶² mood changes noted. Improvement in stress and anxiety was reported by two studies^{156 157} highlighting stress-busting qualities, verbalised as a ‘sense of cool control’ and a ‘release of aggression’.¹⁵⁷ Conversely, studies describe anxieties relating to performance on the golf course.^{62 157} Increased heart rates are noted prior to tournament play, consistent with prematch tension.⁸⁶

Mental wellness

Quantitative and qualitative studies have described benefits related to self and group identity^{157–161} and social connections, many of which have been cultured long term.^{84 161 162} Golf facilitated opportunities for intergenerational interaction,^{163 164} and created opportunities to rebuild social connections^{86 161} and confidence¹⁶⁵ during and post illness.

Self-efficacy, self-worth and physical activity levels improved after a golf intervention in 814 participants with a disability in the USA.¹⁶⁶ In addition, self-worth in golfing populations^{158 161} and self-esteem^{156 167} in sporting populations that include golfers show positive change. An initial analysis of ‘The First Tee’—an at-scale US sport-based development programme—suggests that participants and parents noted improved confidence, interpersonal skills and emotional control.¹⁶⁸ Finally, sunshine, fresh air and kinaesthetic pleasure were identified through qualitative interview responses as contributing factors to potential wellness¹⁶² benefits related to golf.

Table 2 Research priorities related to golf and health

Research priority relating to golf	Comment	Why required
Mental health and illness	Physical activity has an overall positive impact on wellness and mental ill health, but robust, controlled studies with objective measures are required in relation to golf	Weight of evidence low
Systematic reviews relating to golf and health	To explore cause and effect nature of the relationships described	Scoping review methods cannot answer these specific questions, but have been able to map the evidence landscape and indicate where more focused study is required
Muscle strengthening/strength and balance/musculoskeletal benefits	Research on the contribution of golf to muscle strengthening/strength and balance, and potential effects in relation to osteoporosis and osteoarthritis could be important to golfers, practitioners and policymakers looking to provide advice to patients and populations	Weight of evidence low/knowledge gap
Golf carts	Research is needed exploring how health effects/relationships differ between golf played while riding a golf cart and golf played walking the course	Weight of evidence low
Spectating	Research assessing useful physical activity accrued spectating is required. Opportunities exist to shape health behaviours among spectators on course and in daily life using the experience as a ‘teachable moment’	Knowledge gap
Health behaviour change	Research is needed addressing how golfers and potential golfers can be influenced to take part and maintain golfing activity, and investigating and improving knowledge and behaviours related to golf injuries, illnesses and accidents	Weight of evidence low
Economic effects	Research investigating cost savings to health and other services associated with golf, and opportunities to make golf more accessible and affordable for all will inform policy	Weight of evidence low
Specific populations	Research addressing associations between golf and health in (1) disabled and (2) older adult populations may highlight specific benefits/disbenefits	Weight of evidence low

Review

In summary, a number of qualitative and quantitative studies describe improved wellness in golfers, but there are few controlled studies looking at golf and mental health.

Further research priorities

This study has identified research gaps in the existing literature on golf and health with future research priorities outlined in table 2.

Limitations

Scoping reviews are comprehensive, but not exhaustive in identifying literature¹⁶ recognising the balance between the breadth and depth of analysis.¹⁶⁹ Our search was subject to older but relevant sources being less available via databases, search platforms and search engines. Scoping reviews are broad in nature and provide an overview of existing literature regardless of quality, providing a broader and more contextual overview than systematic reviews. Formal assessment of methodological quality is not undertaken when conducting a scoping review,^{14 15 169} and synthesis of the literature quantitatively, nor demonstration of a cause and effect nature for the found relationships is not possible. Golfers are likely different to non-golfers in many ways, with confounding factors a challenge to identify and adequately control. Documented attempts were made throughout the design and conduct of this study to appraise and report evidence in an objective way.¹⁷ Rigorous and reproducible methods have been applied and authors are committed to publish all findings whether findings were positive, negative or not significant.

CONCLUSIONS

This scoping review identified over 300 studies investigating the relationship between golf and health. Golf has been shown to provide moderate intensity aerobic physical activity and therefore could be expected to have the same beneficial effects on longevity, physical health, mental health and wellness associated with

physical activity.¹⁷⁰ The scoping review cannot demonstrate causative effects, but reports evidence that is biologically plausible and relatively consistent, highlighting positive associations between golf and physical health, and mental wellness. The best available evidence suggests that golf may contribute to reduced mortality. The existing evidence supports efforts to promote golf as a sport with overall health benefits. To maximise health benefits, golfers should walk the course rather than riding a golf cart.

Research assessing golf's contribution to muscle strengthening recommendations, the relationships of golf on mental health, golf spectating and health, and the influencing of health behaviours in golfers, have been identified as priorities for further study. Systematic reviews to further explore health effects of golf on specific conditions are also required.

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Contributors All authors have contributed to the development of the research questions and study design. AM, EG and NM identified the method, whilst AM and DA identified existing scoping review frameworks to develop this scoping protocol. AM and LD developed and conducted the search strategy and data extraction. All authors developed the first and subsequent drafts of the manuscript. All authors reviewed and approved the manuscript.

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Competing interests ADM and RAH received an unrestricted grant from the World Golf Foundation to fund this research. The World Golf Foundation agreed to publish findings whether positive, negative, or no associations or effects were found. RAH and ADM are remunerated for clinical work for the European Golf Tour.

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What is known?

- ▶ Scoping reviews provide a useful framework to collate and summarise information on a broad topic.
- ▶ Golf is played by over 50 million people of all ages worldwide.

What this study adds?

- ▶ Playing golf can provide moderate intensity physical activity and has overall positive associations with physical health and mental wellness, while golf may contribute to increased longevity.
- ▶ Disbenefits include (mostly overuse) injuries; accidents are rare, but deleterious consequences of them can be high.
- ▶ Priority areas for future research include the associations and effects of golf on mental health, golf's contribution to muscle strengthening, balance and falls prevention, and influencing health behaviours among golfers and potential golfers. Systematic reviews to further explore the cause and effect nature of the relationships described are merited.

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2.4 Increasing research visibility. Infographic. Golf and Health and other digital resources

Prior engagement with key stakeholders including golfers, policy makers and the golf industry suggested a clear need to have a strategy and tools to communicate and disseminate findings. Generally, golfers wished the information to be shared in simple terms, and in visual form. Golf industry leaders wanted more detail, but also information summaries they could share with golfers/ potential golfers, while policy makers wanted a clear explanation of what scientific findings meant for people and populations. Increasingly academic institutions and funding agencies also value efforts to increase the visibility, uptake, use and impact of work (HEFCE, 2014) by researchers.

Learning about processes to increase visibility, use and engagement regarding the scoping review was also an important part of my professional growth while working on my thesis. The more people the scoping review reached, the more engagement I had, with opportunities to learn from colleague researchers, policy makers and other stakeholders. As outlined in a published editorial (Murray, Duncan, Glover, Griffin, & Tarazi, 2019a) I believe it was my professional duty to learn about knowledge translation and share my research “in a way that works for the target audience”.

Below I briefly outline efforts to increase research visibility, uptake, use and impact, with a fuller exploration in chapter five.

2.4.1 *Increasing research visibility*

The **vision** for the thesis was to add knowledge on the associations between golf and health, that will contribute to improved population health.

To achieve this my **objectives** included a review of the literature, but also provision of information to i) golfers and potential golfers, ii) the golf industry/ facilities, iii) the scientific community iv) policy/ decision makers, regarding what is known about the relationship between golf and health.

To maximise research visibility/ uptake, use and impact of the scoping review, a six-step process described in detail in chapter five was developed and used, and is summarised below.

- i) Assess the need for research
- ii) Carry out the research
- iii) Publish research

- iv) Create digital resources
- v) Share these resources and original research widely
- vi) Evaluate the uptake, use and impact of the research

For each of these steps building relationships and working with key stakeholders can likely support uptake and use.

Having assessed the need for research, carried out and then published the research (open access, and in the leading journal by impact factor in the field) we next created digital resources with an aim of engaging beyond the scientific community, making information from the scoping review as accessible as feasible. Resources were produced that were not intended to be a substitute for reading the scoping review but communicated key findings so a busy reader/stakeholder could digest these and be signposted towards the original article. Any potential audience be that the scientific community, golfers, policy makers or industry to name a few end-user groups needed to hear language they could understand (Murray et al., 2019a). These communication resources included an infographic, podcast and a video animation myself and the research team co-produced with the BJSM.

2.4.2 Infographic

“Infographic” is an abbreviation for an information graphic. A user is up to 6.5 times more likely to remember content from an infographic than by reading text alone (Krum, 2013) and articles that contain an infographic/ visual abstract are more likely to be read than those that do not (Ibrahim, Lillemoe, Klingensmith, & Dimick, 2017). Infographics can be a helpful tool for conveying scientific information clearly (Scott, Fawcner, Oliver, & Murray, 2016), potentially helping uptake and use in an audience wider than traditional consumers of research.

The editor-in-chief of the BJSM who also provided advice regarding research methods and knowledge translation to me during this program of work encouraged the further publication of an infographic, as a knowledge translation tool. I reviewed the literature regarding what makes an engaging infographic, following guidelines (Scott, Fawcner, Oliver, & Murray, 2017) which informed the production of the golf and health scoping review infographic (Murray et al, 2017a). A more detailed discussion of the literature surrounding infographics and knowledge translation tools is found in chapter five.

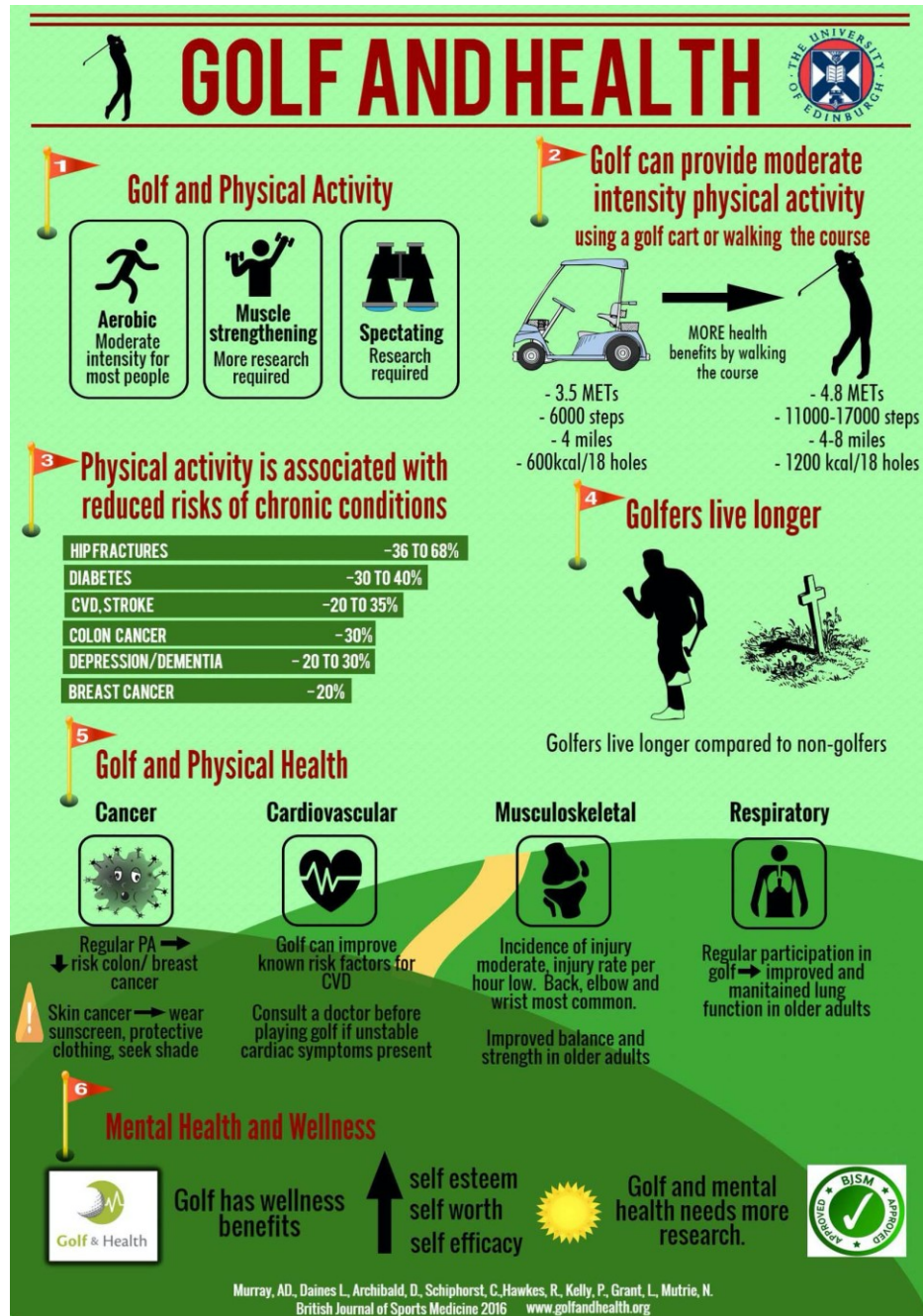
Permissions to publish the golf and health infographic based on findings from the scoping review, within this thesis are granted under the Creative Commons Attribution License (CC BY 4.0; <https://creativecommons.org/licenses/by/4.0/>). A link to the article is shown below.

Infographic. Golf and health.

<http://bjsm.bmj.com/content/51/1/20.extract?sid=36a73391-18e7-473e-a49d-2123eb082959>

Infographic. Golf and health

A D Murray, L Daines, D Archibald, R A Hawkes, C Schiphorst, P Kelly, L Grant, N Mutrie



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2.4.3 Other digital resources

In addition to the golf and health infographic published in BJSM, an animated video and podcast have been produced.

Animation

Animation is a type of video that utilizes text and moving images. Video content is predicted by Facebook to drive 80% of all consumer internet traffic by 2020. I worked with Jennifer Duncan, a medical student doing her elective with me at the Physical Activity for Health Research Centre to produce a Golf and Health animation based on the scoping review which has >30,000 views across different platforms.

A link to the animation is below

<https://www.youtube.com/watch?v=8AjXNeSKYq4&t=12s>

Podcast

Podcasts can offer a 'deeper dive' into a topic. A BJSM podcast (18 minutes) based on the scoping review is found at the link below.

<https://soundcloud.com/bmjpodcasts/andrew-murray-1>

2.4.4 Efforts to share the research widely

Following the publication of the research and having made digital resources (infographic, podcast etc, I facilitated uptake through supporting a press release via the University of Edinburgh, and a website on golf and health (www.golfandhealth.org). Care was taken to ensure that information shared was based on the published science. Key information was shared with leading players who have >20 major titles between them, and other stakeholders were encouraged to share information with their networks. I considered these dissemination efforts as much a part of the PhD as the empirical work, and crucial to meeting the thesis vision. As such these dissemination efforts are documented throughout the thesis. Chapter five, and the published paper from chapter five (Murray et al., 2019c) provides more detail in describing knowledge translation efforts as well as an evaluation of the uptake, use and impact of the scoping review, alongside the other outputs from my thesis.

2.5 Principal findings from the scoping review

Having completed the outputs from this chapter (Scoping Review, Scoping Review Protocol, Infographic and other digital resources) it was necessary to reflect on study one, and how this would inform the next steps for this work.

The principal findings from the scoping review were

- Playing golf can provide moderate intensity physical activity with contributions from swinging the club, and from walking while playing.
- There is evidence that is biologically plausible and relatively consistent, highlighting positive associations between golf and physical health, and mental wellness.
- Priority areas for future research include: the associations and effects of golf on mental health, golf's contribution to muscle strengthening, balance, and falls prevention, and influencing health behaviours amongst golfers and golf spectators, and exploring potential health enhancing physical activity gained by spectators.

2.6 Further discussion and context

Lessons learned, an overview of the uptake, use and impact of the study and a discussion of next steps for my program of research are described next.

2.6.1 *Golf as a physical activity.*

In the published scoping review, forty-nine studies were identified assessing golf as a physical activity (Murray et al., 2017b) and the paragraphs on “golf and physical activity” within the “thematic summary” section summarise the existing literature and are not repeated in full here. Additional relevant information is provided below.

A key theme to emerge is that golf can provide moderate intensity aerobic physical activity and therefore could be expected to have beneficial effects on longevity, physical health, mental health and wellness that are associated with physical activity (Lee et al., 2012; Lim et al., 2012, Smith et al., 2010). It has been important to further delineate Metabolic Equivalent of Task (MET) for golf while walking and carrying clubs, golf while walking and pulling or pushing clubs, and golf while riding a golf-cart, as well as driving range activity. This is helpful information, particularly as the amount and intensity of physical activity is related to the health benefits accrued (Sattelmair et al., 2011; Wen et al., 2011). For players a contribution to physical activity is made from walking while playing, as well as the act of swinging a golf club that has strength and balance demands.

Regarding domains of physical activity, golf contributes to physical activity largely as a leisure time or recreational activity, while providing occupational physical activity for modest numbers of professional players and caddies. This is shown in Figure 5 below, which builds on Laird, Kelly, Brage, & Woodcock (2018), and their description of the domains of physical activity.

Domains of Physical Activity and Golf

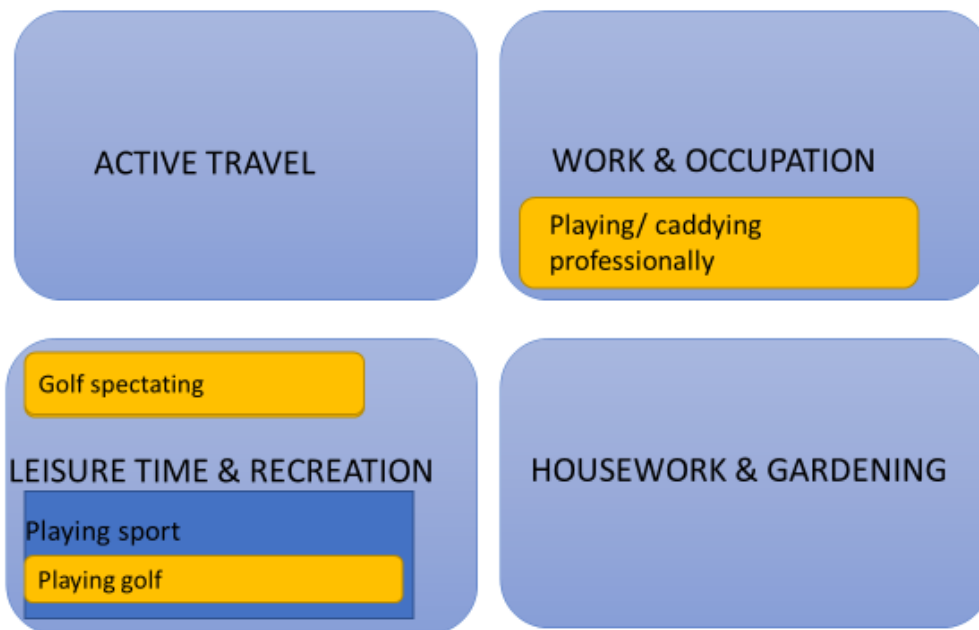


Figure 5. Golf and the domains of physical activity (adapted from Laird et al, 2018)

Older adults (those 65 years or older) are a population that are typically less physically active than younger adults (Hallal et al., 2012; World Health Organisation, 2019). These are an important group to consider with regard to physical activity and golf. Evidence highlights the relative contribution of golf to population physical activity increases in older adults (Kolt, Driver, & Giles, 2004; The Scottish Government, 2015; Strain, Fitzsimons, Kelly, & Mutrie, 2016; Strain, 2018) at a life stage where overall physical activity can diminish. Golf, and other sports like bowls who engage the least active age demographic (older adults) in activity (Strain, 2018), also offer a relatively higher intensity of physical activity for older adults (Broman, Johnsson & Kaijser, 2004).

Golf can help persons and populations meet and exceed minimum government recommendations for Moderate to Vigorous Physical Activity (Murray et al., 2017b). Time spent playing golf without riding a golf cart is non-sedentary/ sit less time (Ainsworth et al., 2011; Dobrosielski et al., 2002; Ikeda, Cooper, Gulick, & Nguyen, 2008; Lampley, Lampley, & Howley, 1977; Moy, Scragg, McLean, & Carr, 2006; Tangen et al; 2013). However, when conducting the scoping review, a clear gap in knowledge existed regarding the contribution of golf to muscle strengthening and balance aspects of physical activity

recommendations and this was identified as a priority for review and further primary research.

Building on the scoping review, I provided primary supervision for a “Rapid review to identify physical activity accrued while playing golf” (Luscombe, Murray, Jenkins, & Archibald, 2017) advising on methods including study selection criteria, data extraction and presentation of data. I performed phase one of the search strategy and reviewed drafts and the final manuscript, which was published in BMJ Open. This study offered a comprehensive overview of golf and physical activity. The relative strengths and limitations of included studies regarding golf and PA had not been evaluated, in keeping with established scoping review methods, thus the rapid review utilised streamlined systematic review methods to do so.

The rapid review, in keeping with the scoping review (Murray et al., 2017a,b) and the Compendium of Physical Activity (Ainsworth et al., 2011) found golf can provide moderate PA, while noting variation in intensity during the sport, and between differing participants (Luscombe et al., 2017). For some younger, athletic populations, golf may be primarily low-intensity, although typically compensated for by volume of physical activity. Further research investigating golf’s contribution to strength and balance recommendations was recommended, noting limited data from only five studies rated “good” or “fair” (Gao, Hui-Chan, & Tsang, 2011; Schachten & Jansen, 2015; Sell, Tsai, Smoliga, Myers, & Lephart, 2007; Tsang & Hui-Chan, 2004, 2010). Using the knowledge from the scoping review and the rapid review, I compared these to United Kingdom’s Chief Medical Officer’s 2019 Physical Activity (Department of Health and Social Care, 2019), generating table 2 below.

Table 1. Golf and PA guidelines (using United Kingdom Chief Medical Officer 2019 Guidelines as reference).

PA Recommendation	Adults (19-64 years)	Older adults (65 years and over)
Moderate-and-vigorous intensity physical activity (MVPA)	Can provide MVPA	Can provide MVPA
Sedentary behaviour	Can provide non-sedentary time	Can provide non-sedentary time
Muscle strengthening	Knowledge gap	Knowledge gap
Balance and co-ordination	Knowledge gap	Some evidence can provide

In terms of key dissemination activities, I presented results from the scoping and rapid reviews in scientific and policy forums including HEPA Europe, Planetary Health, the World Scientific Congress on Golf, the UK All-Party Parliamentary Group on Golf, the UK and Scottish Ministers for Public Health, and to the World Golf Foundation and The R&A amongst others.

Following a presentation delivered by myself and Dr Roger Hawkes to their development committee, The R&A agreed to fund research led by two principal co-investigators in the USA and the UK investigating i) golf and its contribution to muscle strengthening and balance and co-ordination recommendations and ii) the physical and psychosocial benefits and dis-benefits of golf for older adults.

2.6.2 Knowledge gaps and priority areas for future research

We conducted and published a scoping review to provide a rigorous overview of golf and health, mapping and summarising the evidence, and identifying significant gaps in the literature. This would inform the broader field and also the priorities for study for years 2-5 of my work. The priority areas for future research I identified are discussed in the text, and in table 2 of the published scoping review (Murray et al, 2017b). This highlights that “research assessing useful physical activity accrued spectating is required” and that “opportunities exist to shape health behaviours among spectators on course and in daily life using the experience as a ‘teachable moment’”. Given that >10 million spectators attend professional golf tournaments each year (Robinson, Trail & Kwon, 2004), this golf spectating and health knowledge gap is important and the focus of chapter three.

Since the completion of the golf and health scoping review, myself and my co-authors have looked to share our findings widely and discuss with research colleagues how best knowledge gaps can be addressed. Research priorities identified by the scoping review and subsequent activity are shown in table 3 below, while further discussion is contained in chapter five.

Table 2. *Research priorities identified by scoping review and subsequent activity.*

Amended from Murray et al., 2019c, appendix 1. Permission from BMJ group.

Research Priority relating to Golf and Health	2016 Comment from Scoping Review.	Activity 2016-2018
Mental health and illness.	Physical activity has an overall positive impact on wellness, and mental ill health, but robust, controlled studies with objective measures are required in relation to golf. Weight of evidence is low.	Randomised Control Trials. Completed. Golf and cognitive decline. Shimada et al., 2018 Underway. Golf and dementia. Hewson, 2018. Cross Sectional. Completed. Golf and mental well-being. UK Active Research Institute, 2018 a,b. Further detailed research proposals in Australia, France and the UK have been submitted for funding or have been funded.
Systematic reviews relating to golf and health.	To explore cause and effect nature of the relationships described.	Further research to support these reviews required. Systematic review of injuries in professionals completed (Robinson et al., 2018)
Muscle strengthening/ strength and balance/ musculoskeletal benefits	Research on the contribution of golf to muscle strengthening/ strength and balance, and potential effects in relation to osteoporosis and osteoarthritis could be important to golfers, practitioners and policy makers looking to provide advice to patients and populations. Weight of evidence low/ knowledge gap.	Completed Small interventional (Du Bois, Marcione, Castle, & Salem, 2018), and cross-sectional (Stockdale et al., 2017; Stokes et al., 2016, 2018) studies have been conducted. Underway Research funding has been secured by the Golf and Health team to assess strength and balance in golfers compared to controls in RCT/ Intervention studies (University of Southampton, University of Southern California).
Golf-carts	Research is needed exploring how health effects/ relationships differ between golf played while riding a	Cross-sectional (Completed, being written up) Golf-carts versus walking distance, energy expenditure. Exercise intensity. Jayabalan &

	<p>golf-cart, and golf played walking the course.</p> <p>Weight of evidence low.</p>	<p>team, 2019.</p> <p>Golf carts and utility for Osteo-arthritis. Jayabalan & Bergman, 2018.</p>
Golf Spectating	<p>Research assessing useful physical activity accrued spectating is required. Opportunities exist to shape health behaviours amongst spectators both on course, and in daily life using the experience as a 'teachable moment'.</p> <p>Knowledge gap.</p>	<p>Cross-sectional (completed, addressed within thesis)</p> <p>Spectators rate physical activity as important reason for spectating.</p> <p>Spectators gain HEPA while spectating (Murray et al., 2017c, 2018d)</p> <p>Receiving PA messaging at golf tournaments can influence subsequent attitudes and behaviours re PA. (Murray et al., 2019b)</p>
Health behaviour change.	<p>Research is needed addressing how golfers and potential golfers can be influenced to take part and maintain golfing activity, and investigating and improving knowledge and behaviours related to golf injuries, illnesses and accidents.</p> <p>Weight of evidence low.</p>	<p>Some aspects addressed within thesis.</p> <p>Consensus (addressed within thesis).</p> <p>Provision of action plans for golfers, the industry and policy makers (Murray et al., 2018a,b)</p> <p>Intervention (addressed out-with thesis)</p> <p>Golf on referral studies (UK Active 2018a, and other unpublished.)</p> <p>Golf and youth participation. (Go Golf Europe, 2018 a,b)</p> <p>Intervention</p> <p>Receiving PA messaging at golf tournaments can influence subsequent attitudes and behaviours re PA. (Murray et al., 2019b)</p> <p>Understanding behaviours.</p> <p>Why older adults golf? (Stenner, Mosewich, & Buckley, 2016)</p>
Economic effects	<p>Research investigating cost savings to health and other services associated with golf, and opportunities to make golf more</p>	<p>Cross-sectional data with basic economic analysis (UK Active 2018a)</p> <p>Commitment by global golfing bodies regarding</p>

	accessible and affordable for all will inform policy. Weight of evidence low.	improved access for women and girls, those with disabilities, and those new to the sport
Specific populations.	Research addressing associations between golf and health in a) disabled and b) older adult populations may highlight specific benefits/ dis-benefits. Weight of evidence low.	<p>Children/ youth Go Golf Europe, 2018a,b</p> <p>Older Adults Cross sectional- Why older adults play golf. (Stenner et al., 2016)</p> <p>Longitudinal/ RCT- Mental and Physical health. Older adults. Golf. Funded research in Australia, USA, and UK Includes Stenner, Mosewich, Buckley, & Buckley, 2019)</p> <p>Disability 29 national organisations commit to developing golf in players with disability. Research collaborations and opportunities identified. Integration of elite disability players into a professional tournament 2018/ 2019.</p>

Regarding mental health and illness, the evidence is consistent and growing that physical activity can positively impact a range of mental health conditions including anxiety, depression, dementia and wider well-being (Cooney et al., 2013; Goodwin, 2013; Kelly et al., 2018; Larson et al., 2006; Lawlor & Hopker, 2001), although there are some areas further research is required. The scoping review found there is some evidence highlighting improved well-being through golf which include improved self-worth, self-efficacy, self-esteem and social connections (Adatto, 1964; Austin 2003; Beard, 2007; Berlin & Klenosky, 2014; Cann, Vandervoort, & Lindsay, 2005; Kleiber, 2013; Paul, 1991; Walker, 1989). However robust, controlled studies with objective measures regarding well-being, and in particular mental health are required in relation to golf, with the weight of evidence when the scoping review was published being low. This priority area for research was communicated consistently in scientific forums, leading to discussions between research groups and myself. This was an area I carefully considered addressing within original research within this thesis, given the knowledge gap and importance of the area. I chose to assess whether golf spectators could gain health enhancing physical activity, and whether attending a

tournament could provide a teachable moment to increase physical activity. This choice reflected that there was no evidence in this area, compared to a low weight of evidence regarding golf and mental health,

The structure and funding for a randomised controlled trial looking at a golf intervention on a population with dementia has been approved (University of Bedfordshire, Prof Hewson), while a group at Harvard are assessing a golf intervention in patients with Parkinson's Disease. In addition, one group in Melbourne, Australia who I collaborated with during the course of this research and a group from the UK have submitted funding applications looking at golf and neuro-degenerative conditions. These applications are under review. Regarding golf and mental well-being, cross-sectional work from UK active described golfers who play frequently having better mental well-being than those that play less frequently. Golfers also had higher levels of social trust than non-golfers. However, limitations of this work include that confounding variables were not completely controlled for and this work has yet to be published in a peer reviewed publication. A randomised controlled trial found improvements in logical memory but not other cognitive tests in the golf intervention group compared to a control (education only) group (Shimada et al., 2018).

In the previous section I described the rationale for prioritising research assessing the contribution of golf to muscle strengthening and balance recommendations. I shared the scoping review and rapid review findings, that noted the evidence for golf in providing MVPA, and contributing to non-sedentary time, but a relative knowledge gap regarding golf and a contribution to muscle strengthening and balance improving activities. Research groups at the University of Southampton, and the University of Southern California were interested in this area, and further discussions followed with the result that a funding application was made to The R&A, which I presented on the Principal Investigators behalf along with co-author Dr Roger Hawkes. This application was successful, and the University of Southampton and the University of Southern California are now conducting this research. Thus far, small interventional and cross-sectional results indicate muscle strengthening and balance improvements for older adults who play golf (DuBois et al., 2016; Stockdale et al., 2017; Stokes et al 2018), while larger more definitive studies will provide more clarity and are now underway.

These studies also look at wider functional fitness and health issues in older adults. I have also provided advice to colleagues who have assessed why older adults play golf (Stenner et al., 2016), and associations between markers of health and golf in an Australian population (Stenner et al., 2019). Regarding other specific populations, I have met with the

Head of Inclusion and Disability and Chief Executive at the International Golf Foundation, and the executive team at the European Disabled Golf Association to discuss research opportunities. I shared that a knowledge gap exists regarding golf's contribution to health for those with a disability. There are media reports and limited studies assessing golf as a rehabilitation tool from injured personnel with a military background, qualitative and quantitative research may be beneficial.

While conducting this thesis, I have also taken pragmatic opportunities to contribute to advancing knowledge relating to potential health dis-benefits of golf. As the Chief Medical Officer for the Professional Golfers Association European Tour I needed to know what injuries affect golf professionals to inform prevention and intervention strategies. For the published "Systematic Review of Musculoskeletal Injuries in Professional Golfers" (Robinson et al., 2019) I provided primary supervision for this study and manuscript, inputting into study design, other methodological considerations and the writing of the manuscript. The impact of this publication has been the International Golf Federation Medical Commission agreeing to follow the lead of other sports, for example tennis (Pluim et al., 2009), football (soccer) (Fuller et al., 2006) and cricket (Orchard et al., 2016) and build consensus regarding the reporting and recording of illness and injury, injury forms and diagnostic coding. Likewise, a potential risk to golfers noted in the scoping review was excess sun exposure. In order to understand this further, and provide requested guidance to National Federations and professional tours, we collated and summarised current literature on the relationship between golf and skin cancer in a narrative review (Matthews, Preston, Murray, & Hawkes, 2018), before inputting into the development of educational resources for players, and skin screening services.

2.7 Strengths, limitations and lessons learned

Strengths and limitations of the published scoping review are discussed within the review itself in particular within the “limitations” section.

In summary, best practice guidelines (Arksey & O'Malley, 2005; Levac et al., 2010, Peters et al., 2015) were utilised to ensure rigorous, reproducible methods, a comprehensive and systematically conducted literature review, and strike a balance found between breadth of scope, and depth of analysis. This scoping review could set the scene for longitudinal and randomised controlled intervention studies prior to systematic reviews and it is acknowledged scoping reviews do not formally assess methodological quality of included publications, and do not aim to formally quantify the size of health effects (by producing aggregate or pooled effects).

I took time to identify the most suitable methodology, publish a protocol before proceeding in a stepwise fashion. In parallel with this, I considered based on the available evidence, how to maximise potential uptake, use and impact of published research, noting the increased scientific and funding priorities for this (HEFCE, 2014).

In retrospect, there are a few aspects I would have approached differently. I have found with subsequent chapters that beyond reading the published articles, actually making contact and actively conversing with lead authors from seminal publications can be helpful. I have subsequently conversed (via telephone, email, skype, and social media) with authors of relevant scoping reviews. Had I communicated directly with authors of other scoping reviews, this would have saved me considerable time whilst working on the review specifically regarding extracting the data and considering how to structure results/discussion. Since publication, authors seeking to publish scoping reviews on other sports (including rugby, baseball, cricket and tennis) have contacted me and I have provided guidance from my own learning. I am currently working as part of the author team on scoping reviews on rugby (Griffin et al., 2019), cricket (Bullock, Panagodage-Perera, Murray, Arden, & Filbay, 2019), and social media and these are being informed by the things I learned on the golf review.

Immediately after publication, I had a large number of enquiries regarding the research from the popular press, golfers, colleague scientists, and policy makers. Having resources such as an available website to provide up to date information for these end-user groups would have supported them better, a lesson I learned when publishing the scoping review, and

applied when working towards an International Consensus on Golf and Health (Murray et al., 2018a,b) and other research outputs from this thesis.

In the time between the publication of the scoping review (online first 2016), and the write up of this thesis (2019), the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) checklist was published (Tricco et al, 2018). This drew on publications from the EQUATOR (Enhancing the QUALity and Transparency of health Research) network. If I were to commence a scoping review now, I would use this checklist and associated guidance, and have completed a checklist post-hoc for the golf and health scoping review (Appendix 8) which highlights good adherence, with the same best practice publications having informed PRISMA-ScR and the golf and health scoping review.

2.8 Uptake, use and impact summary

As outlined previously, evaluation of the uptake, use and impact from research is an increasing priority for the scientific community and funders. The Research Contribution Framework developed by Dr Sarah Morton (Morton, 2015a,b) provides a practical approach that acknowledges other factors that can contribute to outcomes.

Sarah Morton provided invaluable guidance outlining scientific knowledge regarding uptake, use and impact and specifically the development of an evaluation of the scoping review and other outputs from this thesis.

The published paper “Maximising and evaluating the uptake, use and impact of golf and health studies,” (Murray et al., 2019c) and chapter five of this thesis trace the pathway to impact for the scoping review and subsequent golf and health publications. Figure 6 provides an overview of this, providing context for this chapter.

In summary, the scoping review has made a contribution to knowledge to end-user groups including

- i) The general public/ golfers- with >120 popular press outputs, and direct communications indicating golfers are taking action based on it.
- ii) For the golf industry the scoping review is a primary reference point in industry white papers regarding golf and health and is embedded in curriculums for golf coaches/ professionals.
- iii) For policy makers it has been directly cited in speeches by government ministers and been the focus of discussions and motions of support in the UK Parliament.
- iv) Scientifically it has become a primary reference point in the field, being in the top 1% of all papers by Altmetric, having >33,000 full text/ PDF accesses and 20 citations (as of June 2018). It has helped shape the research agenda, identifying research gaps, and in some instances directly helping to secure funding to address these.

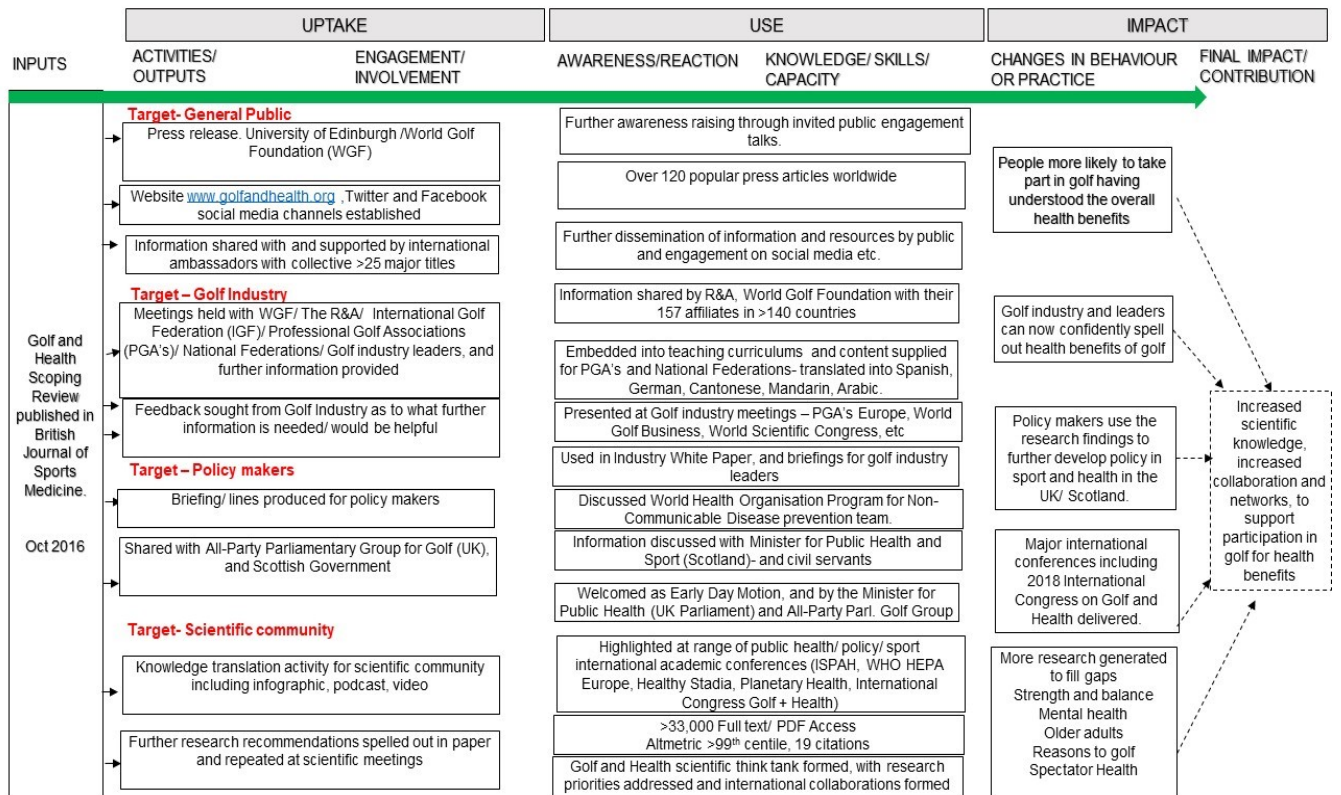


Figure 6. Pathway to impact of golf and health scoping review. Re-produced from Murray et al., 2019c, with permission from BMJ publishing.

2.9 Chapter summary and conclusions

The published scoping review mapped key concepts and evidence regarding golf and health. Golf can provide moderate to vigorous physical activity and is associated with improved physical health and well-being.

Further research priorities identified included investigating whether golf spectators can gain health enhancing physical activity, characterising golf's contribution to strength and balance and assessing associations and effects between golf and mental health.

Communications/ knowledge transfer assets (infographic, podcast, animation/ video) were produced in collaboration with the publishing journal supporting dissemination of findings.

In highlighting what is known, and what is not known about golf and health, it additionally provided next logical steps for this thesis, namely

- i) Addressing knowledge gaps
- ii) Providing guidance to the public, the golf industry, and policy makers regarding what can be done to maximise health benefits accrued through golf, and minimise dis-benefits.

Chapter three- Survey based studies of golf spectating and health

3.1 Introduction

3.1.1 Rationale, objective, and research questions

As described in Chapter one, the over-arching **vision** for the thesis is to contribute new knowledge regarding golf and health, which in turn can contribute to improved population health.

Having achieved the first **objective** of conducting a scoping review of the literature in chapter two and identifying knowledge gaps, the next objective was to conduct original research to address these gaps.

The scoping review indicated that almost all included research related to golf and health focused on the players, but very little was known about spectator health and golf, which is potentially important given that over 10 million spectators attend tournaments each year (Robinson, Trail & Kwon, 2004). Areas of interest developed that arose based on the review findings. These concerned i) the feasibility of conducting research assessing spectator physical activity and motivations regarding PA at and beyond a golf tournament, ii) the reasons for spectators attending a professional golf tournament, and an objective measure of their accrued physical activity, and iii) opportunities to shape health behaviours amongst spectators both on course, and in daily life

The objective and research questions for this chapter are shown below in Figure 7, which builds on the overall vision and objectives for this thesis shown in Figure 2, chapter one.

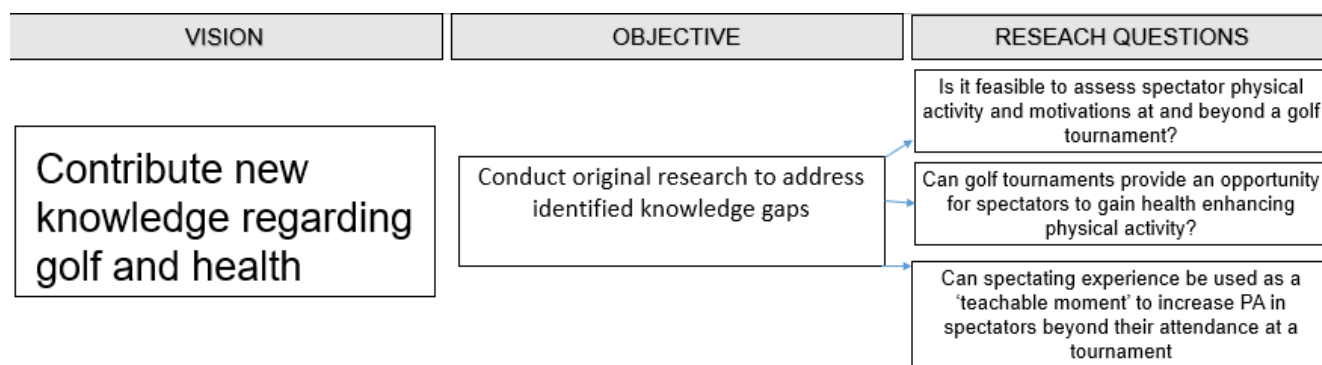


Figure 7. Objectives and research questions for spectator health studies

Following an introduction, two related papers and one infographic are presented from work to address these gaps published in BMJ Open Sports and Exercise Medicine (BMJSEM), and the British Journal of Sports Medicine (BJSM). As with the scoping review, further

exploration, discussing the principal findings, strengths and limitations, context and the approach taken to ensure maximal research use, research uptake, and research impact are provided in this chapter to support the published papers.

Published research outputs comprise

- Murray, A. D., Turner, K., Archibald, D., Schiphorst, C., Griffin, S. A., Scott, H., ... & Mutrie, N. (2017c). An observational study of spectators' step counts and reasons for attending a professional golf tournament in Scotland. *BMJ open sport & exercise medicine*, 3(1), e000244.
- Murray, A. D., Hawkes, R. A., Kelly, P., Grant, L., & Mutrie, N. (2019b). Do golf fans walk the talk? Follow-up of spectators' beliefs and self-reported physical activity 3 months after they attended a professional golf tournament in the UK. *BMJ open sport & exercise medicine*, 5(1), e000503.
- Murray, A., Scott, H., Archibald, D., Turner, K., Griffin, S. A., Schiphorst, C., Hawkes RA, Kelly P, Grant E & Mutrie, N. (2018d). Infographic. Golf spectating and health. *Br J Sports Med*, 52(6), 415-416.

3.1.2. Author contributions

Regarding these research outputs, I conceived the studies and identified the research questions, guided by the Scoping Review findings. Following this, I led the development of methods, drafting of questionnaires, and collection of the data both in the field and by survey. I collated, summarised and reported the results. I led the writing of all manuscripts, further developing them with input from supervisors and colleagues prior to submission. I developed a strategy to maximise uptake, use and impact of studies, including engagement with key stakeholders, and the production of communication assets for example infographic, video, podcast and press release.

Professor Nanette Mutrie, Professor Liz Grant, Dr Roger Hawkes and Dr Paul Kelly provided guidance in the development of methods and the conduct of the research. Kieran Turner provided additional input regarding methods and helped data collection along with Dr Steffan Griffin, Chloe Schiphorst, Hilary Scott and Dr Jack Luscombe. For each paper, all authors helped develop, review, and approve final manuscripts. Hilary Scott assisted with the design of the infographic.

3.1.3. Further Background

The international consensus document “Investments that Work for Physical Activity” (Global Advocacy for Physical Activity, 2012) and the Global Action Plan for Physical Activity (World

Health Organisation, 2019) highlight the importance of the communications/ public education, and the sports sector in increasing physical activity. Major sporting events have thus far largely failed to demonstrate a legacy of increased physical activity, despite events and stakeholders that support them (for example local and national government) often stating this as an outcome they desire (Bauman, Murphy, & Matsudo, 2013; Weed et al., 2012, 2015). Efforts have generally focussed on getting to participate in the sport, or the activities showcased at these events, despite the literature suggesting that events should concern themselves with promoting physical activity (for example walking) more generally (Bauman, Murphy, & Matsudo, 2013).

Golf spectating and health was identified by the scoping review as a clear knowledge gap, and this was an area where stakeholder interest was high. Major sporting events are always going to occur, and promoters and policy makers in particular expressed an interest in learning how to maximise public health benefits from these. Recent Olympic (London 2012), and Commonwealth (Glasgow 2014) multisport games had stimulated particular interest in the UK regarding this, while golf events attract >350,000 spectators in the UK each year.

Golf spectating at tournaments and events may offer opportunities for the promotion of physical activity and in particular walking that are different to many other sporting events. There has been growth in the knowledge base for walking in the last two decades in particular, with increasing evidence for improved longevity, physical health and mental health (Boone-Heinonen, Evenson, Taber & Gordon-Larsen, 2009; Kelly, Williamson, Niven, Hunter, Mutrie, & Richards, 2014, 2018). A scoping review investigating walking and mental health suggested that walking outdoors, in a natural environment can provide additional benefits to indoor walking (Kelly et al., 2018).

As highlighted by the scoping review, golf spectators can spend time walking around the golf course and wider event arena, likely gaining physical activity (Hansen & Gauthier, 1993, 1994; Lyu & Lee, 2013; Robinson et al., 2004) though whether the dose is sufficient to enhance health is not clear. Whether spectators respond positively to health messaging from elite golfers is also unknown. Marketeers and commercial brands have often utilised leading players to promote a range of products and concepts, and I felt utilising them to promote healthy behaviours is an area worth exploring.

In addition to spectator physical activity and motivation for PA being a research gap, in practical terms my position as Chief Medical Officer for the European Tour Golf, an

organisation that operates the three leading men's professional tours in Europe, offered a pragmatic advantage in the conduct of the research, and potentially with practical implementation if relevant beyond this. These factors combined to make research in this direction pragmatic, feasible and an identified PhD focus.

3.2 Cross sectional research of spectators' step counts, and reasons for attending a professional golf tournament in Scotland.

This article that follows was published in British Medical Journal Open Sports and Exercise Medicine in July 2017.

The appendix to this thesis includes further information from the conduct of this study namely

Appendix 9- participant information sheet

Appendix 10- participant consent form

Appendix 11- participant questionnaire from observational study. This file was a supplementary file in the published article.

Permission to publish this study and supplementary files within this thesis is granted under the Creative Commons Attribution License (CC BY 4.0;

<https://creativecommons.org/licenses/by/4.0/>). A link to the article is shown below.

- An observational study of spectators' step counts, and reasons for attending a professional golf tournament in Scotland.

<https://bmjopensem.bmj.com/content/3/1/e000244>

The full article is presented below

An observational study of spectators' step counts and reasons for attending a professional golf tournament in Scotland

Andrew D Murray,^{1,2} Kieran Turner,^{1,3} Daryll Archibald,³ Chloe Schiphorst,¹ Steffan Arthur Griffin,^{4,5} Hilary Scott,^{1,6} Roger Hawkes,^{4,7} Paul Kelly,¹ Liz Grant,⁸ Nanette Mutrie¹

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► Additional material is published online only. To view please visit the journal online (<http://dx.doi.org/10.1136/bmjsem-2017-000244>).

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ABSTRACT

Background Spectators at several hundred golf tournaments on six continents worldwide may gain health-enhancing physical activity (HEPA) during their time at the event. This study aims to investigate spectators' reasons for attending and assess spectator physical activity (PA) (measured by step count).

Methods Spectators at the Paul Lawrie Matchplay event in Scotland (August 2016) were invited to take part in this study. They were asked to complete a brief questionnaire with items to assess (1) demographics, (2) reasons for attendance and (3) baseline PA. In addition, participants were requested to wear a pedometer from time of entry to the venue until exit. **Results** A total of 339 spectators were recruited to the study and out of which 329 (97.2%) returned step-count data. Spectators took a mean of 11 589 steps (SD 4531). 'Fresh air' (rated median 9 out of 10) then 'watching star players', 'exercise/physical activity', 'time with friends and family' and 'atmosphere' (all median 8 out of 10) were rated the most important reasons for attending.

Conclusion This study is the first to assess spectator physical activity while watching golf (measured by step count). Obtaining exercise/PA is rated as an important reason for attending a tournament by many golf spectators. Spectating at a golf tournament can provide HEPA. 82.9% of spectators achieved the recommended daily step count while spectating. Further research directly assessing whether spectating may constitute a 'teachable moment', for increasing physical activity beyond the tournament itself, is merited.

BACKGROUND

Researchers, policy-makers and practitioners concur that regular physical activity (PA) benefits persons of all ages and backgrounds. It has positive effects on mental health, physical health and longevity for both individuals and populations.^{1–4}

A recent aim of major sporting events has been to secure a legacy of increased PA or participation in sport following the event.⁵

Major multi-sport games have failed to achieve an inherent, substantial PA legacy.⁶ Measures that could help address this lack of legacy include (1) producing a clear strategy to increase participation and (2) de-emphasising the sporting element and promoting PA more generally (for example, walking) rather than simply the sport being played.^{7,8}

Golf can provide a novel and suitable narrative to provide a link between sport, walking and potential health benefits.⁹ Golf playing and spectating is particularly popular in middle-aged and older adults in North America, Europe and Asia in particular.¹⁰ This demographic typically have lower levels of PA compared with younger adults and children.^{11–13}

Collectively, tournaments in the USA alone can draw over 10 million spectators per year.¹⁴ Those watching the action at several hundred tournaments on six continents worldwide may have the opportunity to gain health-enhancing physical activity (HEPA) on the available square miles of playing arena.¹¹ Indeed, the existing literature suggests that golf spectators rate perceived 'health benefits' and 'exercise' as important considerations in attending tournaments,^{15–17} with Lyu and Lee segmenting the motivations of spectators into 'excitement seekers', 'exercise seekers', 'interest seekers' and 'escape seekers'.¹⁷ Our recent scoping review identified knowledge gaps, namely that no studies have characterised the effects of spectating at golf tournaments on PA knowledge or PA levels.^{9,18} We aim to contribute to these knowledge gaps. We first address critical feasibility questions and assess the extent to which spectating delivers opportunities for PA.



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Table 1 Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
<ul style="list-style-type: none"> ► Spectators at the European Tour Paul Lawrie Matchplay ► Aged ≥ 18 years ► Able to walk (walking aids permitted) ► Unstable cardiovascular disease not reported 	<ul style="list-style-type: none"> ► Non-spectators (for example staff, marshals, players, caddies) ► Spectators that had taken part in the study on previous days ► Aged under 18 years ► Inability to walk ► Reported unstable cardiovascular disease (critical aortic stenosis, unstable angina, myocardial infarction within 6 weeks—a medical doctor was part of the research team and could provide individual case advice)

Our research questions were the following:

1. Is studying spectator PA through pedometer measured step counts feasible at a professional golf tournament?
2. What reasons do spectators at a European Tour event identify for their attendance?
3. Can spectators gain a relevant dose of PA (measured by step count) while attending a professional golf tournament?

METHODS

We conducted a cross-sectional study consisting of two linked elements: a questionnaire completed by spectators on entering the course and a measure of step count from the time a spectator entered the venue until the time they exited. Ethical approval was granted (15 July 2016) by the Moray House School of Education Ethics Committee at the University of Edinburgh.

Data collection

Data were collected on all days of tournament play (4–7 August 2016) at the European Tour Paul Lawrie Matchplay event in Scotland. The European Tour meteorological service recorded temperatures of between 18°C and 21°C (highs) and 9°C–13°C (lows). Winds were light to moderate, except on the final day of play where 40–45 miles/hour gusts were experienced. Rain fell for <10% of the duration of play.

Spectators attending the event were approached by one of six trained researchers who invited spectators to read a two-page participant information sheet,

Table 2 Baseline characteristics of participants

Age (years)	Men	Women	Total
18–39	49	18	67
40–59	105	46	151
≥ 60	68	43	111
Total	222	107	329

detailing the purposes of the study as they arrived. Those willing to partake were assessed against the inclusion and exclusion criteria stated in [table 1](#) below by a researcher.

Those eligible were invited to sign a consent form, and following this completed a baseline questionnaire. This questionnaire was devised from a review of relevant previous studies^{15–17 19} and was refined following discussion with the research team and officials from the European Tour golf. The full questionnaire is shown in the online [supplementary appendix 1](#) and included seven demographic items, eight items including a free text option assessing reasons for spectating, and three items assessing self-reported current PA levels and interest in becoming more physically active. These last three items were facilitated by a member of the research team using a validated tool (Scot-PASQ; NHS Health Scotland, UK).

Following this, a researcher fitted a Silva Ex Step (Silva, Stockholm, Sweden) pedometer to the lateral aspect of the right hip region of each participant, noting the time this was fitted. Participants were asked to check the pedometer was registering steps after 1–2 min, and if not it was repositioned to an adjacent position. The European Tour works with a Scottish charity that champions walking 'Paths for All'. Paths for All recommended the Silva Ex Step as having high usability compared with other devices. A brief validation of five Silva Ex Step devices was performed with <5% difference for all devices noted compared with Actigraph (Pensacola, Florida, USA). Paths for All also offered all spectators information relating to spectating and health, as is standard at Scottish-based European Tour events.

The participant then spectated for a length of time of their choosing and in a manner of their choosing. Prior to exiting the venue, participants returned the pedometer to a member of the research team who checked and recorded the number of steps taken and the time returned.

Data analysis

With regard to feasibility, we decided, rather than to specify in advance a hypothesis to determine feasibility, that we would assess feasibility on a subjective basis based on response, recruitment, compliance and the human and equipment resources required.

Table 3 Reasons for attendance at the Paul Lawrie Matchplay as rated by participants on entry to the venue						
	Watch star players	Learn from star players	Non-golfing entertainment	Atmosphere	Fresh air	Exercise/physical activity
No of respondents	338	337	333	332	333	334
Median	8.00	7.00	5.00	8.00	9.00	8.00
IQR	2	4	5	2	3	4
Mode	8	8	1	8	10	10

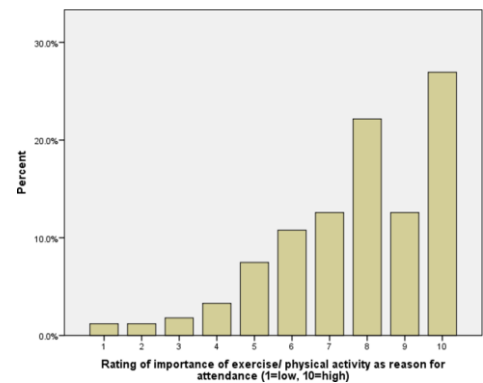


Figure 1 Participant rating (1–10) of 'exercise/physical activity' as a reason for attendance on entry to the venue.

Pedometer failure is a recognised issue in step-count studies. We had specified criteria for inclusion and exclusion of data. When pedometers were returned, the values were entered into the database, and the researcher assessed them for face validity. The participant sometimes offered information unprompted that the pedometer had failed. Where there was clear error, the result was excluded.

Statistical Package for the Social Science V.22 software was used for data management and analysis. Variables were assessed for normality with means or medians reported as appropriate. We used independent samples t-tests to explore any possible differences in step counts by age and gender. The association between minutes spectating and steps taken was tested using Pearson correlation coefficient.

RESULTS

Feasibility/spectator characteristics

European Tour figures show the 2016 Paul Lawrie Matchplay was attended by 1500 paying spectators. Approximately 600 spectators in total were approached to take part in the study. A total of 339 spectators were recruited to the study and agreed to complete the questionnaire. Of those who did not agree to take part, most indicated that they were in a hurry to go and watch the golf. Of these 339 participants, 329 collected step count data and returned the pedometer (97.2%). Twenty (6.1%) pedometers failed to register accurate readings. Participants recruited and completing the study represented 22.6% of the eligible tournament population. While not part of the study, researchers were approached by marshals, children, golf caddies, professional players and returning spectators requesting literature relating to golf and health and/or pedometers to monitor their step count highlighting interest in this topic beyond direct participants.

The baseline characteristics of participants are shown in table 2. Approximately two-thirds of participants were men, with men between 40 and 59 years old most strongly represented.

Table 4 Mean/median number of steps taken by gender

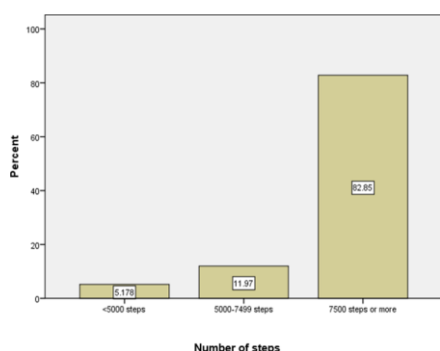
Gender	Measure	Statistic
Men	Mean	12 172.5
	95% CI for mean	Lower bound
		11 586.6
	Upper bound	12 758.4
	Median	11 362.5
	SD	4327.6
	Minimum	1576
Women	Maximum	25 312
	Mean	10 314.1
	95% CI for mean	Lower bound
		9361.9
	Upper bound	11 266.2
	Median	10 039.0
	SD	4724.2
	Minimum	310
	Maximum	25 098

Reasons for attendance

Within the baseline questionnaire, participants were asked to rate reasons for spectating on a scale of 1 (of no importance) to 10 (of extremely high importance).

Median and mode values showing spectators' stated reasons for attendance are shown in Table 3. 'Fresh air' (rated median 9 out of 10) then 'watching star players', 'exercise/physical activity', 'time with friends and family' and 'atmosphere' (all median 8 out of 10) were rated the most important reasons for attending (table 3).

In terms of the importance of reasons for attendance, exercise and physical activity was of interest to this paper on spectator health. The relative percentage for spectator rating of importance of exercise/physical activity as a reason for attending is displayed in figure 1.

**Figure 2** Number of spectators: <5000 steps, 5000–7500 steps and >7500 steps.

Measured spectator PA

Table 4 shows the mean/median number of steps taken by spectators, stratified by gender. The independent samples t-test revealed a statistically significant difference by gender with men taking approximately 1858 more steps on the day they attended (95% CI 784 to 2933, $p < 0.001$). There were no important differences in step counts by age group.

Figure 2 displays the number of steps taken categorised into (1) inactive, (2) low active and (3) meeting moderate to vigorous physical activity guidelines.²⁰

Number of steps

An increasing number of minutes spectating had a moderate association with total steps taken ($r = 0.67$). This shows that on average, participants attending for longer accrued more steps.

Questionnaire data from the SCOT PAS-Q items collected as participants entered the venue highlighted that 89.3% reported meeting the aerobic moderate to vigorous physical activity guidelines in the previous week, while 68.1% reported being 'interested in being more physically active'.

DISCUSSION

Principal findings

Feasibility

This study indicates that it is feasible to study adult spectator PA (by pedometer-measured step counts) at a professional golf tournament. Approximately 56% of spectators approached agreed to participate, and of these, 97.2% returned questionnaire and step-count data.

It should be noted that it was not practical to engage with every spectator who entered the venue. Spectators can typically access the venue through more than one entrance and often arrive in groups having largely travelled by coach transfer. A larger number of researchers would be needed to engage with a larger volume and proportion of attending spectators.

Spectator reasons for attending

Spectators rated a number of reasons for attending this professional golf tournament as highly important. 'Watch star players', 'atmosphere', 'fresh air', 'exercise/physical activity' and 'time with friends and family' all scored median and mode values of 8 out of 10 or greater. Importantly, for this work, obtaining exercise/PA can be a motivation for attending for participants at this event. The median rating was 8 out of 10, with a mode of 10, representing 'of extremely high importance'.

The extent to which spectating delivers an opportunity for PA

This is the first published study to measure golf spectator PA by step count. Data show participants took a mean of 11 589 (SD 4531, range 25 002) and a median of 11 086 steps. Through spectating alone, 82.9% of participants met Tudor-Locke *et al*'s daily guidelines indicative of a 'physically active lifestyle' from activity while spectating with 94.8% of spectators meeting either 'low active' or 'physically active' lifestyle.²⁰ As may be expected, an increasing number of minutes spectating had a positive association with increased total steps taken. There were no apparent differences in step counts by age group, but there was a statistically significant and potentially clinically relevant difference by gender with male participants taking approximately 1858 more steps per day than female participants.

Comparison to the literature and explanation for findings

Spectator reasons for attending

A large body of research has assessed spectator motivations for attendance at sporting events, but most of these pertain to team-based sports,¹⁴ with data specific to golf limited.^{14–17} McDonald *et al* found clear spectator motivation differences between golf spectators and spectators of other sports.²¹

Watching star players is the most powerful motivator for golf spectator attendance in most previous studies conducted,^{14–17} and the current study supports the importance spectators place on this. Robinson *et al* argue that the prime marketing focus for events should be on specific well-recognised golfers playing.¹⁴ However, spectators in our sample rate at least equally highly other reasons for spectating including 'fresh air', 'spending time with friends and family' and 'exercise/physical activity'. These data support Lyu and Lee's assertion that factors such as these offer attractive marketing angles to

tournament organisers/promoters, with the aim of increasing spectator volume and engagement.¹⁷

These factors were not probed as explicitly in Robinson *et al*'s study of US spectators, with the questionnaire employed not golf specific. It is known motivations for golf spectators are different to team sports, being broader and less homogeneous.²¹

Spectator attitudes towards changing exercise/PA

Evidence from North America, Asia and Europe is consistent and growing that exercise/PA can be a motivator for attending golf tournaments.^{15–17} Golf tournaments and their spectators are heterogeneous, and some may be more motivated than others by PA benefits based on individual, cultural, climatic and tournament differences. They may also be likely to be meeting minimum PA levels already. Our study did not find significant age-related and gender-related differences in attitudes of spectators towards exercise/PA. The literature broadly supports a greater emphasis of these benefits by event promoters,^{15–17} which may be beneficial in terms of engagement with spectators, local communities and funding organisations.

PA gained while spectating

There are no previous published studies that measured the levels of PA attained by golf spectators. Unpublished data (obtained via personal correspondence, Event Scotland) from the 2014 Ryder Cup, Gleneagles, UK, show over 20 000 spectators tagged every checkpoint at locations on course, indicating they had walked 8 kilometres each, or 100 000 miles collectively. At the 2016 Shenzhen Open, Shenzhen, China, 6500 spectators completed a 'health walk' intervention, of 10 km each, adding up to a distance seven times the length of the Great Wall of China (personal communication, Shenzhen Open).

Step counting using pedometers is a well-established method of measuring PA by the general public, researchers and policy-makers.²⁰ Data showed that 82.9% of participants met Tudor-Locke *et al*'s moderate to vigorous physical activity daily guidelines (>7500 steps) from activity while spectating alone, when measured by step count. This is the first study to report PA levels in golf spectators. The self-reported interest in exercise/PA as a reason for attending may be important in explaining the high level of PA achieved. For some, attending the event may represent a deliberate attempt to gain HEPA, while others gain incidental HEPA through their desire to observe particular golfers or the course.^{16 17} Female step count may be lower than male spectators due to factors that may include footwear choice. Equivalent studies of spectator populations' PA at other tournaments would likely be influenced (positively or negatively) by factors including but not limited to ambient weather conditions, cultural factors, type of tournament and terrain/walkability of the golf course.

Recommendations for practice/policy and research

Recent strategies from the Department of Culture, Media and Sport and Sport England among others have highlighted the value of spectating at sporting venues and the potential for inspiration and increasing PA.^{22 23} Increasingly, sports organisations/franchises, governing bodies for sport, stadia operators and others are being encouraged to develop practices and policies that promote improved public health for fans and communities. These include efforts relating to healthy eating, alcohol consumption, tobacco use and sustainability as well as promoting PA.

This study confirms it is feasible to study spectator PA and attitudes towards PA in a golf setting. Response rates were good, and compliance rates among participants were exceedingly high. We showed that a reasonable sample size can be achieved with a team of six trained researchers. This will be important information for future work and potential power calculations for sample size requirements. A well-structured questionnaire and collaboration with the tournament organisers are also highly recommended.

Golf spectating does offer an opportunity for PA in this setting and population. Attendance can thus be encouraged, and spectators can be supported to do so in an active fashion in promotional efforts ahead of and during each professional golf event. Golf tournament event planning, marketing efforts, golf course choice and architecture should reflect this. Fans/spectators can receive public health benefits, while tournament organisers/sponsors may realise revenue and corporate and social responsibility benefits. With two-thirds of participants indicating an interest to be more physically active, it may be an opportunity for intervention in a 'contemplative' population. While the participants were largely already meeting the guidelines, it should be noted that this is a minimum level of PA and more is better, and that maintenance of PA is critical in adult and ageing populations.

Research priorities for the future include

- ▶ Assessing what methods for providing PA information/intervention (eg, big screen, leaflet, poster, email, direct conversation) are welcomed by spectators.
- ▶ Investigating whether the spectating experience could be used as a teachable moment to raise awareness of personal PA behaviour, national guidelines and the benefits of PA and influence behavioural change.
- ▶ Further study of spectator PA levels in different contexts, and with a larger and more representative sample, which may allow a better estimation of accrued PA, and potential gender and age differences.
- ▶ Using qualitative methods to undertake an in-depth exploration of why exercise/PA is valued or not valued by spectators, and exploring the barriers to and facilitators of active spectating at professional

golf tournaments among senior tournament decision makers.

- ▶ Studying opportunities for other sports/events to explore spectator PA.

Strengths and limitations

This study was conducted with a pragmatic design and approach.

Strengths include a novel approach in raising awareness of PA through sport and demonstrating public health benefits of sporting events that have thus far been elusive. It also demonstrated the feasibility of conducting research with spectators at professional sporting events in collaboration with event organisers, governing bodies and athlete ambassadors. Research co-produced in this way may help implementation/scale up and assist impact and future intervention delivery in this manner. It is the first to objectively report PA accrued while spectating, while other findings are consistent with previous work describing spectator attitudes to exercise/PA.^{15–17}

A number of limitations are evident. Although approximately 600 spectators were approached, those who agreed to wear a pedometer and take part in the study may be more interested in PA and be more physically active than those who declined leading to a selection bias. Observed results may be susceptible to bias; individuals may have modified their responses and behaviours (for example walked more or less) based on what they believe is socially desirable and awareness of their behaviours being observed (Hawthorne effect). Twenty individuals had conclusive proof of pedometer error (for example from GPS/other pedometer), and their step counts were excluded. A smaller number of individuals expressed an opinion that the pedometer had underestimated their step count, but were included due to lack of objective evidence to support, which may have led to an underestimate of their and the observed population's step count. Step-count data were collected from entry to exit of venue, but did not capture participant PA during the other parts of their day. These limitations and sample size mandate caution in generalising to golf spectators more generally, particularly in different contexts.

CONCLUSIONS

Encouraging people to be more active more often is a public health imperative. A key element of generating increased PA in relation to a sporting event may be to de-emphasise participation in the sport itself and promote PA more generally. Evidence from this study showed that spectators' rate 'exercise/physical activity' as an important reason for attending the golf tournament and that spectating can provide HEPA.

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Contributors ADM, KT, CS, PK, LG and NM contributed to the development of the research questions and study design. ADM, KT, CS, SAG and HS collected and extracted the data. All authors developed the first and subsequent drafts of the manuscript. All authors reviewed and approved the final manuscript.

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Competing interests ADM and RH received an unrestricted grant from the World Golf Foundation to fund this research. The World Golf Foundation agreed to publish findings whether positive, negative, or no associations or effects were found. RH and ADM are remunerated for clinical work for the European Tour Golf.

Patient consent Obtained.

Ethics approval School of Education, University of Edinburgh.

Provenance and peer review Not commissioned; externally peer reviewed.

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3.3 Further discussion and context

The study helped answer the research questions set. I was able to determine

- i) That it is feasible to study adult spectator physical activity at a professional golf tournament
- ii) That obtaining physical activity/ exercise can be a motivator to attend and
- iii) That health enhancing physical activity can be gained by spectators attending a tournament

Morton, when drawing together a model to evaluate knowledge into action interventions (Morton, 2015a,b) highlights that “relationships and networks are the most important way in which research is shared, used and re-used” drawing on learning from Best & Holmes, 2010; Kingdon, 1995; and Sabatier & Jenkins-Smith, 1993, and the interactive model of Weiss, 1979. The next logical step was to feedback initial findings to stakeholders, which include golf spectators themselves, golf tournament organisers, and policy officials.

The observational study presented here in chapter three and published in BJSM (Murray et al., 2017c) identified the below as knowledge gaps/ research priorities

- 1) “Assessing what methods for providing PA information/ intervention (e.g. big screen, leaflet, poster, email, direct conversation) are welcomed by spectators.
- 2) Investigating whether the spectating experience could be used as a teachable moment, to raise awareness of personal PA behaviour, national guidelines and the benefits of physical activity and influence behaviour change.
- 3) Further study of spectator physical activity levels in different contexts, and with a larger and more representative sample which may allow a better estimation of accrued PA, and potential gender and age differences.
- 4) Using qualitative methods to undertake an in-depth exploration of why exercise/ physical activity is valued or not valued by spectators and exploring the barriers to and facilitators of active spectating at professional golf tournaments amongst senior tournament decision makers.
- 5) Studying opportunities for other sports/ events to explore spectator physical activity.”

Discussions with key stakeholders

Discussions with key stakeholders determined my next steps. I had in person, telephone, or email conversations with >10 tournament organisers from bodies including the European Tour, The Asian Tour, IMG, and the R&A. Most tournament organisers, with whom I

discussed initial findings, wanted to know what method would be the most effective in conveying the opportunity to gain physical activity and potential health benefits to spectators. They quickly recognised a marketing angle to attract, and potentially re-attract spectators to their event, while also noting potential commercial and Corporate and Social Responsibility benefits to them. However, they questioned whether this would best be done via leaflet, billboard, big screens or other mechanisms, asking what the end-user (spectators) would typically favour.

Public health experts (including my supervisors, and the Chief Medical Officer for Scotland), tended to stress during informal conversations and supervisory meetings that a single day where health enhancing physical activity is achieved would have some but limited benefit for personal or population health. However, if attendance could enhance knowledge regarding physical activity for health, and help attendees contemplate, or better still actually increase physical activity in daily life then more significant benefits for people and populations may occur.

I thus resolved to address the first and second research priorities identified above, while also being mindful of other identified research opportunities. To this end, in addition to my formal research, I supported the development of spectator health interventions in China, Indonesia, Spain, and the United Kingdom, which included both male and female professional tournaments. I discussed with sports organisations/franchises, governing bodies for sport, stadia operators and others, practices and policies that promote improved public health for fans and communities. I also discussed with government ministers in Scotland, United Kingdom and Malaysia, the need to promote physical activity (in particular walking) more generally. This would be more evidence based than an exclusive focus on increasing participation of the sport being observed and would need clear strategy to increase participation for all of society (Bauman et al., 2013; Murray et al, 2017c; Weed et al., 2015). In section 3.4, I present the subsequent study/research that aimed to address the knowledge gaps thought to be most important by event organisers and by public health experts namely

- 1) Assessing what methods for providing PA information/ intervention (e.g. big screen, leaflet, poster, email, direct conversation) are welcomed by spectators.
- 2) Investigating whether the spectating experience could be used as a teachable moment, to raise awareness of personal PA behaviour, national guidelines and the benefits of physical activity and influence behaviour change.

3.4 Do golf fans walk the talk? Follow-up of spectators' beliefs and self-reported physical activity 3 months after they attended a professional golf tournament in the UK.

This article was published in British Medical Journal Open Sports and Exercise Medicine in February 2019.

Discussions with golf spectators, golf tournament operators (Paul Dunstan- the European Tour, Kevin Barker- the R&A, Cho Minn Thant- Asian Tour), scientists (Dr Paul Kelly, Prof. Nanette Mutrie, Prof. Liz Grant -University of Edinburgh, Prof. Charlie Foster- International Society for Physical Activity for Health) and policy makers (Derek Grieve, Caspian Richards, Craig Morris- The Scottish Government,) informed the development of the study and research questions. I led the development of research questions and study design, with academic input regarding methods from supervisors Dr Paul Kelly, Prof. Liz Grant and Prof. Nanette Mutrie. I conducted all data collection and extracted the data. I led the development of the first and subsequent drafts of the manuscript. All authors reviewed and approved the final manuscript.

The appendix to this thesis includes
-Appendix 12- participant questionnaire.

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Do golf fans walk the talk? Follow-up of spectators' beliefs and self-reported physical activity 3 months after they attended a professional golf tournament in the UK

The full article is presented below
<https://bmjopensem.bmj.com/content/5/1/e000503>

Do golf fans walk the talk? Follow-up of spectators' beliefs and self-reported physical activity 3 months after they attended a professional golf tournament in the UK

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ABSTRACT

Background Previous research of spectators at professional golf tournaments has highlighted that obtaining exercise/physical activity (PA) can be a motivator to attend, and that spectators can engage in health-enhancing PA while at the event. We assessed whether attending a golf event and receiving an intervention improve knowledge and change attitudes related to physical activity, and self-reported physical activity 3 months later.

Methods Follow-up observational study. Spectators at a European Tour Golf event were given a leaflet about physical activity and health. Three months after that event, we emailed a questionnaire to all 326 spectators who had participated in the original study and provided us their contact details.

Results 135 spectators (41.4%) completed the questionnaire. Among responders, 68.0% 'agreed/strongly agreed' that their knowledge relating to PA had increased, 65.1% agreed/strongly agreed that receiving this information at the event made them consider increasing physical activity in daily life and 40.4% reported that they had increased their physical activity during the 3 months after the golf tournament.

Principal findings/conclusions Golf spectators may contemplate/prepare to increase PA in daily life while a smaller number self-report an increase in PA during the 3 months post intervention at a golf tournament. Spectators' preferred method for receiving information about 'active spectating' is via a big screen. These findings are presented with caution, as respondents may not be representative of all golf spectators.

BACKGROUND

Regular physical activity (PA), and interventions that promote PA, can positively impact longevity, and both physical and mental health.^{1–3} The 2013 economic burden of physical inactivity to health globally was conservatively estimated at US\$53.8 billion.⁴ A clear aim for practitioners, policy-makers and indeed researchers is to support and influence more people to be more active

What are the new findings?

- ▶ Many golf spectators contemplated, or self-report having actually increased physical activity post receiving an intervention at a professional tournament.
- ▶ Public education interventions at golf tournaments may benefit spectators' individual health and well-being and may contribute to public health and well-being.

How might findings impact practice in the future?

- ▶ Sporting event organisers can be encouraged to consider public health education and/or interventions.
- ▶ Fans/spectators can receive health benefits, while tournament organisers/ sponsors may find revenue and corporate and social responsibility (CSR) benefits.

more often. Global targets to reduce physical inactivity by 10% by 2025 and 15% by 2030 have been set.⁵

There is no single or simple solution to the complex problem of physical inactivity. Best investments to increase levels of PA have been described, working in partnership and across sectors that include (1) communication and public education, (2) urban design and infrastructure, (3) sport and recreation, and (4) community programmes.^{5–7}

One initiative that may contribute to addressing physical inactivity is using golf tournaments. Professional golf tournaments draw over 10 million spectators per year.⁸ The best available evidence suggests that golf spectators report 'exercise/physical activity' and 'potential health benefits gained' as considerations in attending professional golf tournaments.^{9–13} In golf, unlike many other sports where spectators are seated, spectators

often walk portions of the course when watching the action.

Collaborations between The European Tour, The R&A, The World Golf Foundation and academic institutions have been established to promote PA at golf tournaments which include some of the biggest male (the Open Championship, the Ryder Cup) and female (Women's British Open) golf events globally. Our previous research has highlighted that tournament spectators can gain health-enhancing PA. Our previous study showed that 84.7% of participating spectators achieved their daily recommended PA, when measured by step count, while spectating.¹²

However, the overall public health benefit of a single day of spectating even for 10 million persons is modest. Gaps in knowledge exist around:

1. Whether the spectating experience could be used to influence knowledge, perceptions and attitudes regarding PA beyond the tournament;
2. Whether the spectating experience could be used as a 'teachable moment' to increase PA in spectators beyond their attendance at a tournament;
3. Preferred methods for providing information during the tournament.

We aimed to contribute to those knowledge gaps through this follow-up study. Our research questions were:

1. How do spectators report knowledge, perceptions and attitudes regarding PA 3 months after attending a golf event and providing baseline data?
2. Do spectators report that the event influenced levels of PA 3 months after the golf tournament?
3. What methods of providing information and encouraging behaviour change do spectators report favouring?

METHODS

Approximately 600 persons out of 1500 paying spectators attending the European Tour Paul Lawrie Matchplay event, Scotland, UK (4–7 August 2016) were provided with information relating to spectating and health in written form having been approached by trained researchers at random.

The inclusion and exclusion criteria, detailed in [table 1](#), were used to determine suitability.

Following consent, 339 spectators completed a questionnaire. The participant was offered the opportunity to wear a pedometer and then spectated in a manner of their choosing. Prior to exiting the venue, participants returned the pedometer to a member of the research team who checked and recorded the number of steps taken, and the time returned. These step count data and reasons for attendance data have previously been published.¹²

Three months following the event, a questionnaire was emailed via Google forms (Google, Mountain View, California, USA) to each individual who had provided consent and an email address (n=326). A reminder email was sent 2 weeks later. The questionnaire was developed from studies assessing PA knowledge in other population groups,^{14 15} using key concepts from Prochaska and DiClemente's stages of change model,^{16–18} and following author discussion.

RESULTS

Emails requesting completion of the questionnaire was sent to 326 persons, of which 11 were rejected by the server. In total, 135 out of a potential 326 participants returned the questionnaire representing 41.4% of those eligible. Of those 135 completing the survey, 129–131 responses were received for each question.

Responses of the 135 respondents on a five-point Likert scale are shown in [table 2](#) and are summarised below.

- ▶ 68.0% (n=131) agreed or strongly agreed that receiving information at the Paul Lawrie European Tour event about the benefits of walking/PA helped increase their knowledge in this area.
- ▶ 58.9% (n=129) agreed/strongly agreed that receiving information will make them consider being more physically active at golf tournaments.
- ▶ 65.1% (n=129) agreed/strongly agreed that receiving information at the tournament will make them consider being more active in everyday life.
- ▶ 40.4% (n=131) agreed/strongly agreed that they had done more PA (including walking) since spectating at the Paul Lawrie golf tournament.
- ▶ 36.9% (n=130) agreed or strongly agreed that having been provided with information about potential health benefits of spectating make it more likely they will attend a golf tournament.

Table 1 Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Spectators at the European Tour Paul Lawrie Matchplay	Non-spectators (eg, staff, marshalls, players, caddies)
▶ Aged 18 or over	▶ Aged under 18 years
▶ Able to walk (walking aids permitted)	▶ Inability to walk
▶ Unstable cardiovascular disease not reported	▶ Reported unstable cardiovascular disease (critical aortic stenosis, unstable angina, myocardial infarction within 6 weeks—a medical doctor was part of the research team and could provide individual case advice)
▶ Able to provide email address	Email address not provided

Table 2 Perceptions, attitudes and behaviours regarding physical activity, and relation to spectating at Paul Lawrie Matchplay

Item	Number of responses	% Strongly agree	% Agree	% Neither agree nor disagree	% Disagree	% Strongly disagree
Walking while spectating at golf events is likely to be beneficial for health. How much do you agree with this statement?	131	61.8	35.9	0.8	1.5	0.0
Receiving information at the Paul Lawrie European Tour event about the benefits of walking/physical activity helped increased my knowledge in this area. How much do you agree with this statement?	131	21.4	46.6	22.9	7.6	1.5
Receiving this information will make me consider being more physically active at golf tournaments. How much do you agree with this statement?	129	17.8	41.1	33.3	7.0	0.8
Receiving this information has made me consider being more physically active in daily life. How much do you agree with this statement?	129	17.8	47.3	25.6	7.8	1.6
I have done more physical activity (including walking) since spectating at the Paul Lawrie golf tournament. How much do you agree with this statement?	131	7.6	32.8	38.2	16.8	4.6
Being provided with information about potential health benefits of spectating make it more likely I will attend a golf tournament. How much do you agree with this statement?	130	12.3	24.6	46.2	16.2	0.8

When asked as to the most useful ways to give golf spectators information about the benefits of walking the course, information provided on the big screens constructed around the course was the most popular option. Further detail is shown in [figure 1](#).

DISCUSSION

Principal findings

This study showed that it was feasible to collect follow-up data related to PA for health from a sample of golf tournament spectators. Results showed positive self-reported views on the usefulness and impact of receiving PA for health information at golf tournaments.

Feasibility and generalisability

Obtaining follow-up data at 3 months via a questionnaire for spectators attending golf tournaments is feasible—the

response rate was 41.4%. Participants who responded to the survey may or may not be typical/representative of golf spectators, so the results should be interpreted accordingly.

Influencing knowledge, PA levels, behaviours and attitudes

A clear majority of respondents (68.0%) agreed or strongly agreed that information received at this golf tournament had helped increase their knowledge of PA for health. Almost two-thirds indicated that receiving information relating to active spectating had influenced them to consider becoming more active in everyday life.

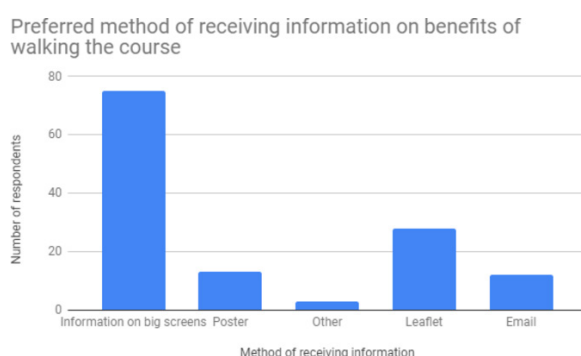
Around two-fifths of respondents indicated that they had increased their physical activity levels at least 3 months post intervention. This increase was self-reported as opposed to measured by pedometer to maximise participation and minimise participant and research team burden.

Providing PA information to spectators

Some spectators (36.9%) agreed or strongly agreed that being provided with information about potential health benefits of active spectating would make it more likely that they will attend future golf tournaments. This offers an additional attractive marketing angle for tournament promoters. Spectators' preferred method for receiving this information was via the big screens at golf events, followed by leaflet, with poster and email communication less popular.

Comparison with the literature and explanation for findings

There is little previous research regarding the provision of information on PA to golf spectators, their attitudes

**Figure 1** Preferred method of providing information to golf spectators on the benefits of walking the course.

towards PA⁹⁻¹³ and interventions to influence PA levels. There is no research following up any intervention regarding PA and golf spectators. Thus, comparisons will be made with a broader evidence base.

Knowledge and attitudes relating to PA for health

Previous research from this golf spectator cohort discovered that they have high habitual levels of PA compared with the general population.¹² We speculate that many golf spectators are likely to be golfers themselves and thus are more likely to be regularly physically active. Spectating at golf tournaments does offer spectators the opportunity to move around and follow play from a variety of locations. We could not identify studies of cohorts of spectators from other sports and their knowledge/habits relating to PA.

Public education and communication are recognised as an investment that works in increasing PA.^{6,7} Prochaska and DiClemente's transtheoretical/stages of change model was originally developed for smoking cessation and has been supported and adapted for sport/PA.^{18,19} Being underinformed on potential consequences of a health behaviour may lessen the chances of positive behaviour change.²⁰ Providing information via for example big screens, in event programmes or in leaflet form at golf events can be considered public education.

Providing education can help shift decisional balance in favour of progressing positively along the stages of change.^{18,21} It is likely that if education/intervention is provided by persons or in a context that persons identify with/admire, then it may be well received.^{22,23} Football Fans in Training leveraged players, club and sporting club identities to influence education and behaviour change.²² Our study engaged with professional golf players (tournament host and previous major champion Paul Lawrie) to provide key messages in the literature provided. Sixty-eight per cent of respondents reported that information received at the golf tournament had helped increase their knowledge in this area. While they may not be fully representative of all spectators at this and other golf tournaments, it would appear that some spectators can be positively engaged in learning about PA for health.

Influencing PA levels

In total, 65.1% of our sample indicated that receiving information relating to active spectating had influenced them to consider being more active in everyday life. Even for those meeting the minimum guidelines for PA, greater health and well-being benefits can be gained by doing more, for most people. Using Prochaska and Di Clemente's stages of change/trans-theoretical model,^{16,17,20} these persons can be represented as being in the 'contemplative', 'preparation' or 'action' phase when surveyed.

Over two-fifths (40.4%) of respondents in the present study self-report positive behaviour change in increasing PA at 3 months post intervention. The magnitude of

increase was not assessed so as to maximise participation (minimise participant burden). These persons can be represented as being in the 'action' phase when surveyed. Maintaining improved PA levels would provide longevity, physical and mental health benefits to people and populations.

With many spectators contemplating, preparing to take action, or taking action to increase PA, interventions at tournaments have the potential to be a teachable moment aimed to move participants further along the cycle of change, and positively influence PA knowledge, and achieved PA. We underscore that it is not clear whether the sample who responded to our survey are representative of other spectators at this, or other golf events. Nevertheless, there is an important proportion of golf spectators whose knowledge and behaviours can be positively influenced.

Providing PA information and intervention to spectators

To increase PA generally,^{5,6} and more specifically to achieve a legacy after a major sporting event,^{23,24} strategy and collaboration are required. A meta-analytic review of tailored health behaviour change interventions shows that tailoring for the audience, to theoretical concepts of the stages of change and to context is important.²⁵ Collaboration to assist tailoring and delivery for this initiative was achieved with a walking charity (Paths for All), academics (University of Edinburgh), tournament promoters (the European Tour, 4Sports), professional golf players, and local and national policy-makers (East Lothian, the Scottish Government, the (UK) All-Party Parliamentary Group on Golf), which likely contributed to the success of the intervention and can assist further delivery at future tournaments.

Co-benefits for tournament promoters and methods of information provision

Over a third of spectators (36.9%) agreed or strongly agreed that being provided with information about potential health benefits of active spectating make it more likely that they will attend future golf tournaments. This offers an additional attractive marketing angle for tournament promoters aimed at increasing spectator volume (and revenue) and engagement. This is in keeping with other studies suggesting more priority could be given to promoting exercise/PA benefits of attending golf events.^{9,10,12} Spectators' preferred method for receiving this information is via the big screens, followed by leaflet. These are both common methods for sharing information at golf and other major sporting events. Both these methods likely offer value, as printed material can be tailored to appeal across a range of stages of change, while spectators welcome the engagement of the big screen/billboard.

Implications and recommendations for research, policy and practice

Studies of spectator populations at other tournaments are likely to be influenced by factors including, but not limited to, cultural factors, type of tournament, engagement of player ambassadors and local facilities for PA. Thus, while further larger research studies may seem attractive, small-scale implementation followed by pragmatic evaluation and the implementation of improvement and, if appropriate, scale-up science may offer more value. Broad principles will apply, but the detail is likely to be different based on many factors and a pragmatic approach may be best.

Governing bodies for sport, golf promoters and marketers can be encouraged to collaborate with leading players, PA experts and a range of other stakeholders to encourage practices and policies that promote walking at the event,^{26 27} but also using the ‘teachable moment’ of attendance at tournaments to impact knowledge around physical activity and encourage positive health behaviour change. This could improve public health for fans and communities, and need not be limited to increasing PA, but also support healthy eating, sustainable transport, wearing sunscreen and so on.

Golf spectating does offer an opportunity for PA in this particular setting and population. Attendance can be encouraged, and spectators can actively be supported to engage in PA through promotional efforts ahead of and during each professional golf event.²⁶ Fans/spectators can receive public health benefits, while tournament organisers/sponsors may find revenue and corporate and social responsibility benefits. Collaborations thus far have produced interventions at leading tournaments worldwide including the Ryder Cup, the Open Championship, The Women’s British Open, the Shenzhen Open (China), Indonesia Open and Andalucía Masters (Spain) among others. Potential benefits of promoting PA for spectators at events are shown in [table 3](#).

Strengths and limitations

This study was pragmatic in its approach.

Strengths include building on the existing literature and frameworks to describe an innovative approach to engage with spectators at a major sporting event. Those study participants reported an increased awareness of PA benefits, and in some cases increases in reported PA levels. Although further study is required, we discovered that attendance at a golf tournament could

present a teachable moment, and that there are potential untapped public health benefits related to major sporting events. This study demonstrated that over 40% of those eligible returned completed questionnaires via email and that conducting research following up spectators from sporting events is feasible. It also describes the value of co-production/collaboration which will support improvement of interventions and scale-up where relevant.

Limitations are apparent. While all those who agreed to take part were emailed and sent a reminder, those who completed the survey may be a unique subset, potentially more interested in PA than those who did not return correspondence leading to potential selection bias. Individuals were aware that they were taking part in a study and may have changed their behaviours recognising they were being observed (Hawthorne effect). Twenty-four persons supplied email addresses that failed to deliver or were illegible, while an unknown number may have ended up in ‘spam’ folders. While the tournament took place in August, follow-up was in October onwards, when weather conditions and other factors may affect people’s motivation and ability to achieve PA. No objective measures of PA levels beyond the event were captured. The sample size and other limitations limit generalisability, particularly recognising the worldwide distribution of golf tournaments and significant differences in culture/context.

CONCLUSIONS

Post intervention, many golf spectators contemplated increasing PA in daily life while close to half of this sample self-report having actually increased PA. Spectators’ preferred method for receiving information on PA benefits, and how this can be achieved is via the big screens erected at major tournaments.

Public education interventions at golf tournaments may benefit spectators’ individual health and well-being, while local authorities may see a contribution to public health and well-being. Tournament promoters may attract an increased volume of spectators, while interventions can help achieve company corporate and social responsibilities.

These data are presented with caution, recognising that while the findings are novel and point to potential exciting opportunities to deliver to the WHO’s agenda of increasing PA, those responding to the survey may not be fully representative of spectators at golf tournaments.

Table 3 Potential benefits of promoting physical activity for spectators at events

Members of public/spectators	Tournament promoters	Government/local authority
Individual health and well-being	Increased volume of spectators—revenue Corporate and social responsibility	Legacy from event Public health and well-being

Acknowledgements The authors wish to thank Paths for All, the European Tour Golf and 4Sports for their input and collaboration at the Paul Lawrie Matchplay tournament. Tournament host Paul Lawrie, as a player, provided leadership in highlighting potential opportunities for players to promote physical activity among spectators. In addition, we acknowledge and thank Kieran Turner, Chloe Schiphorst, Hilary Scott, Steffan Griffin and Jack Luscombe for their help with data collection.

Contributors ADM, PK, RAH, LG and NM contributed to the development of the research questions and study design. ADM collected and extracted the data. All authors developed the first and subsequent drafts of the manuscript. All authors reviewed and approved the manuscript.

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Competing interests ADM and RAH received an unrestricted grant from the World Golf Foundation to fund this research. The World Golf Foundation agreed to publish findings whether positive, negative, or no associations or effects were found. RAH and ADM are remunerated for clinical work for the European Tour Golf.

Patient consent for publication Not required.

Ethics approval Ethical approval was granted by the Moray House School of Education Ethics Committee at the University of Edinburgh.

Provenance and peer review Not commissioned; internally peer reviewed.

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3.5 Efforts to encourage visibility, uptake, use, and impact

3.5.1 Increasing research visibility

The over-arching **vision** for this thesis was to contribute knowledge regarding what is known about golf and health, and what can be advised to maximise health benefits, and minimise the health dis-benefits of golf.

I aimed to contribute knowledge to

- i) Golfers, golf spectators and the general public,
- ii) The golf industry/ facilities,
- iii) The scientific community,
- iv) Policy/ decision makers

In the strengths and limitations section of chapter two, I described that in retrospect I would have liked to have better supported golfers and potential golfers, the golf industry/ facilities, and policy makers with engaging content from the scoping review, as most of the communications tools (infographic, podcast, and animation) were aimed at the scientific community. This recognises that demonstration of uptake, use and impact of published research is gaining increasing priority for universities and funding bodies (Best & Holmes, 2010; Higher Education Funding Council for England (HEFCE), 2014; The UK Economic & Social Research Council, 2015;), being a prominent part of the United Kingdom Research Evaluation Framework (REF). With an aim of engaging beyond the scientific community, information from spectator health studies was made as accessible as feasible.

Information was also provided in lay terms in the press, and on a website

www.golfandhealth.org commissioned by the World Golf Foundation to share findings from our my research, and other relevant research. In trying to achieve our aims of contributing knowledge to golf spectators, the general public and the golf industry, professional golfers were deliberately engaged to produce content.

Following an in person conversation with the World Golf Foundation Chief Executive Steve Mona, a summary and brief was provided to the executives and communication leads for the World Golf Foundation, and other leading golf tournament organisers such as the European Tour, the Asian Tour, The R&A, and promoters such as IMG. The approach taken was to directly engage with all constituent member organisations of the World Golf Foundation, who agreed to cascade findings through their networks. I also made it clear I could support practical implementation of interventions if that were welcome. I assisted with checking the

proposed text, and design of resources for big screens, billboards, event programs for events such as the Ryder Cup, The Open Championship, The Women's British Open, and tour events in China, Spain and Indonesia. Typically, I would suggest bullet points of information, while the event team would add a local flavour, translate if necessary, and involve a professional designer/ agency to produce the final assets. An example of this from the Women's British Open, one of Golf's five majors is shown in figure 8.



Figure 8. Billboard and big screen information provided at Women's British Open.

Specific discussions with Government ministers for public health were set up both in Scotland and the United Kingdom, aiming to understand how golf tournaments can support improved public health both at, and after the event. Outcomes included their attendance at tournaments thus observing spectator health interventions directly, collaboration regarding other initiatives including European Disabled Golf Association events which took place using the same infrastructure as European Tour events, and further sharing of this information through parliamentary channels. These included motions in parliament, and incorporation into briefs for ministerial and civil service colleagues.

For the scientific/ academic community, communication tools included an infographic, and video animation co-produced with the BJSM.

Infographic and digital resources

An infographic was published by the British Journal of Sports Medicine. I led the development of the first and subsequent drafts with design and creative input from Hilary Scott. All authors reviewed and approved the final infographic.

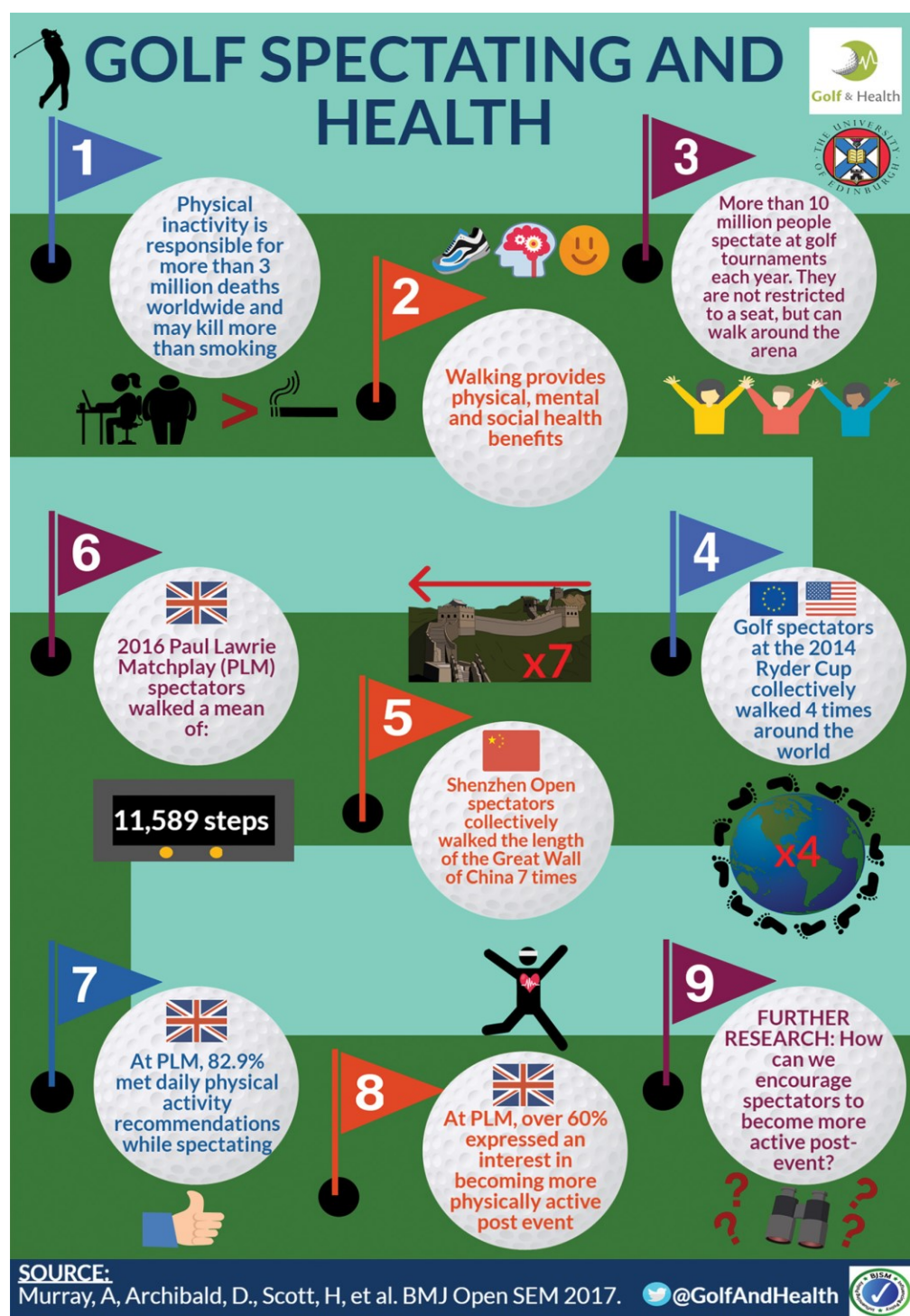
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Infographic. Golf Spectating and health.

<https://bjsm.bmj.com/content/52/6/415>

Infographic. Golf spectating and health

Andrew Murray,^{1,2} Hilary Scott,^{1,3} Daryll Archibald,⁴ Kieran Turner,¹ Steffan Arthur Griffin,⁵ Chloe Schiphorst,¹ Roger Hawkes,⁶ Paul Kelly,^{1,7} Liz Grant,⁸ Nanette Mutrie^{1,7}



Infographics

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highlighting potential opportunities for players to promote physical activity amongst spectators. We thank Jack Luscombe for his assistance with data collection.

Competing interests This research was part funded by an unrestricted grant for the World Golf Foundation, who committed to publishing results whatever the findings. AM and RAH work as clinicians for the European Tour Golf.

Patient consent Obtained.

Ethics approval Ethical approval was granted by the Moray House School of Education Ethics Committee, University of Edinburgh.

Provenance and peer review Not commissioned; externally peer reviewed.



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Video/ Animation

I led the development of an animation, working with Jennifer Duncan, to produce a Golf Spectating and Health animation based on published papers.

A link to the animation is below

<https://www.youtube.com/watch?v=1oR9P9UE0VE>

3.6 Overall principal findings from the golf spectator health studies

I led the conduct of original research to address a knowledge gap identified by the scoping review. Having published the research outputs from this chapter namely

- i) an observational study of spectators' step counts, and reasons for attending a professional golf tournament in Scotland
- ii) follow-up of spectators' beliefs and self-reported physical activity 3 months after they attended a professional golf tournament in the UK
- iii) infographics and digital resources,

I reflect on these studies, and how this would inform the next steps for my programme of work.

The principal research findings from the spectator health studies were

- It is feasible to conduct research assessing golf spectators and their motivations for attending a professional tournament, their step count data, and the effectiveness of public health interventions.
- Obtaining exercise/ physical activity is rated as an important reason for attending a tournament by many golf spectators
- Spectating at a golf tournament can provide health enhancing physical activity with 82.9% of those studied at a UK based event meeting public health recommendations
- Public education interventions at golf tournaments may benefit spectators' individual health and well-being and may contribute to public health and well-being having potential to act as a 'teachable moment'.

The value of working with key stakeholders, including professional golfers, tournament organisers, policy makers and colleague researchers throughout the process was re-affirmed.

3.7 Further discussion and context

3.7.1 *Feasibility of conducting research with golf spectators*

The scoping review (Murray et al., 2017b) had noted this area as a clear knowledge gap. No research existed that assessed spectator physical activity at a tournament measured by step count. In addition to the feasibility considerations discussed in the published papers, key logistical challenges included liaising with multiple stakeholders, including the tournament organisers, tournament promoters, professional golfers, and local authorities. Further research assessing physical activity interventions would be beneficial in other golfing (for example different countries, cultures etc) and non-golfing contexts (for example other sports or mass spectator events), and stakeholder buy in and a recognition of cultural and event specific detail would be important. This would include seeking the support of prominent local players. Whether the support of professional golfers/ professional athletes from other sports is feasible depends on a range of factors. Often these athletes and organisations receive a large volume of requests to support initiatives. Our research, and other evidence suggests “that if education/intervention is provided by persons or in a context that persons identify with/admire, then it may be well received” (Gray et al., 2013; Janis & Mann, 1977; Murray et al., 2019b; Noar, Bernac & Harris, 2007). In our discussions with professional golfers, we highlighted a low time demand for them, and potential reputational benefits for them and the sport based on their association with health messaging. In terms of feasibility for conducting the research with spectators, I ensured the time demand for spectators to take part in the research was short, and understood and found locations close to main entrance points to recruit participants.

3.7.2 Reasons for attending a tournament by many golf spectators

I have described reasons for attendance at the Paul Lawrie Matchplay as rated by participants on entry to the venue. These study findings are in keeping with research findings (Hansen & Gauthier, 1993, 1994; Lyu & Lee, 2013; Robinson et al., 2004) that “exercise/ physical activity” can be an important reason for attendance. Findings from these specific spectators at this specific tournament may or may not be generalisable to different types of tournament, venues, crowds or geographies. To gain further insights and to aid potential implementation, following publication, I informally discussed findings with Chief Executives from each of The European Tour, The R+A, the Asian Tour, The World Golf Foundation, and the International Golf Federation. These leaders saw opportunity to promote golf tournaments as an opportunity to spend time with friends and family, gain fresh air and physical activity, as well as the traditional focus of show-casing the chance to see leading players. Proactively, some of these organisations engaged with commercial partners to help

share this narrative and put in place public health interventions which included spectator health initiatives, but also addressed issues of sustainability and limiting single use plastic, and to make golf events increasingly inclusive. These research findings have made a contribution to more events building health and well-being into their marketing strategy and content delivered to spectators.

However these golf industry leaders all pointed out in some form of words that although fresh air, time with friends and family and physical activity were near equivalent to “watching star players” as a reason for attendance in my/ our study, their experience across hundreds of golf tournaments was that spectator numbers are boosted most by the presence of star players. They also highlighted the history and prestige of tournaments like the Ryder Cup or the Open Championship being an additional draw for spectators. Championship managers at the European Tour agreed with Paul Dunstan, Operations Director, Ryder Cup Europe as well as for the Paul Lawrie Matchplay where our research was conducted who shared in personal correspondence

“Certain players like Rory McIlroy and Tiger Woods will move the needle wherever an event is staged. Other considerations are the history of an event- people want to watch the Ryder Cup or the BMW PGA. Also local interest and culture are important. There are certain countries where we will get big crowds and others less so”.

3.7.3 Spectating at a golf tournament can provide health enhancing physical activity and benefit health for individuals and the general public.

Golf spectators can obtain health enhancing physical activity while at a professional tournament. In my research sample, many golf spectators contemplated increasing PA in daily life while over 40% of this sample self-report having actually increased PA three months later. While these findings point to exciting opportunities to engage with sporting figures and institutions to promote health it is necessary to present these data with caution, noting limitations we have described.

As evidence of uptake and use, in my role as Chief Medical Officer for the European Tour and in various other roles, I provide input for >80 golf tournaments per year, attending approximately 15 per year in person. At many of these, one or several government ministers will attend and are often interested to hear of the health enhancing physical activity that can be obtained by spectators, with some encouraged to walk the course themselves.

Discussing this research with various ministers has also been a useful way to discuss the health benefits of physical activity more widely, and discuss opportunities relating to the World Health Organisation’s Global Action Plan for Physical Activity (World Health

Organisation, 2019). The Solheim Cup 2019 was an example where all government cabinet ministers were briefed on the event, and at least 5 attended in person. Figure 9 below shows an example of a quote provided to the press by the Minister for Public Health and Sport, carried by radio, newspapers but also in this example National Health Service websites.

Joe FitzPatrick, Minister for Public Health, Sport and Wellbeing, echoed Dr Murray's message that the 2019 Solheim Cup will positively impact the health and wellbeing of everyone who took part in the event.

He said: "I warmly welcome this research from the Golf and Health Project which emphasises the health benefits of attending the 2019 Solheim Cup at iconic Gleneagles. The findings prove that spectating at a golf event is an active pursuit.

"While the primary factor for fans will be seeing up close the best of USA and Europe battle it out for the greatest prize in women's golf, the supplementary benefits are almost as compelling. The more spectators explore the beautiful golf course, the greater the impact on their physical and mental wellbeing."

Figure 9. Screenshot of National Health Service website quoting the Minister for Public Health and Sport describing my research and the interventions developed from this.

3.8 Strengths and limitations and lessons learned

Strengths and limitations of the spectator health research are discussed within the published papers themselves.

Involvement of tournament organisers, and government officials, and my own involvement in both the research and medical provision at golf tournaments presents both a strength and limitation. A risk of bias exists, given conflicts of interest that include tournament organisers potentially benefitting reputationally and financially, and the government claiming a legacy of increased physical activity from sporting events it supports if research findings were positive. However, input from these stakeholders is extremely valuable for the research and also the practical implementation of public health initiatives at future events. The same stakeholders that supported the existing research in Scotland helped implement interventions at the Open Championship, Women's British Open, Scottish Open and Solheim Cup on the same shores. It is very likely that these conflicts of interest will arise for other researchers assessing spectator health in other countries, and in other sports. Overall, we felt it beneficial to collaborate with event organisers, local government and others, but committed to publish the results regardless of whether the results would be construed as negative or positive for these bodies.

Methodological limitations including sample size, potential selection bias, and a reliance on self-report rather than objective data when following spectators up beyond the event are outlined in detail in the published papers. Further work, in different contexts is required to establish the extent to which the findings can be generalised to other populations (external validity). The validity and reliability of the questionnaires were not formally investigated.

A strength of this research has been to provide a model, and practical support for stakeholders to institute this intervention in a range of contexts, with low or zero cost and little other perceived downside. Providing public health interventions is now a regular occurrence at European Tour, and other golfing events such as the Ryder Cup, the Open Championship, the BMW PGA, Scottish Open and Women's British Open. This follows the best available evidence which includes i) tailoring an intervention with information from people and organisations that the spectators admire (Gray et al., 2013; Noar et al., 2007;) and ii) de-emphasizing the sporting element and encouraging people to walk more (Bauman, Bellew & Craig, 2015; Bauman et al., 2013; Weed et al., 2015).

My research showed that spectators' preferred method for receiving information about 'active spectating' is via a "big screen" which was over 3 times as popular as via leaflet, or

any other method. The information we provided spectators during our research was via leaflet. In retrospect, I would have informally polled 50-100 spectators at an event, and determined a preference for mode of receiving information prior to initiating the research. To gain further insights, I conducted brief and informal market research at the Open Championship which confirmed that spectators like big screen (which can provide flexible and updating content), but also information towers (with highly visible, engaging content) and also integration into the event program (which was not presented as an option in our research). Less favoured are email, leaflet, or conventional poster. Examples of implementation of these information towers and big screen content a year are seen below in Figure 10. It may be that provision of information on big screen/ information towers and in the program would have been a more effective method of providing information to spectators during my research, where a leaflet was provided to each spectator.

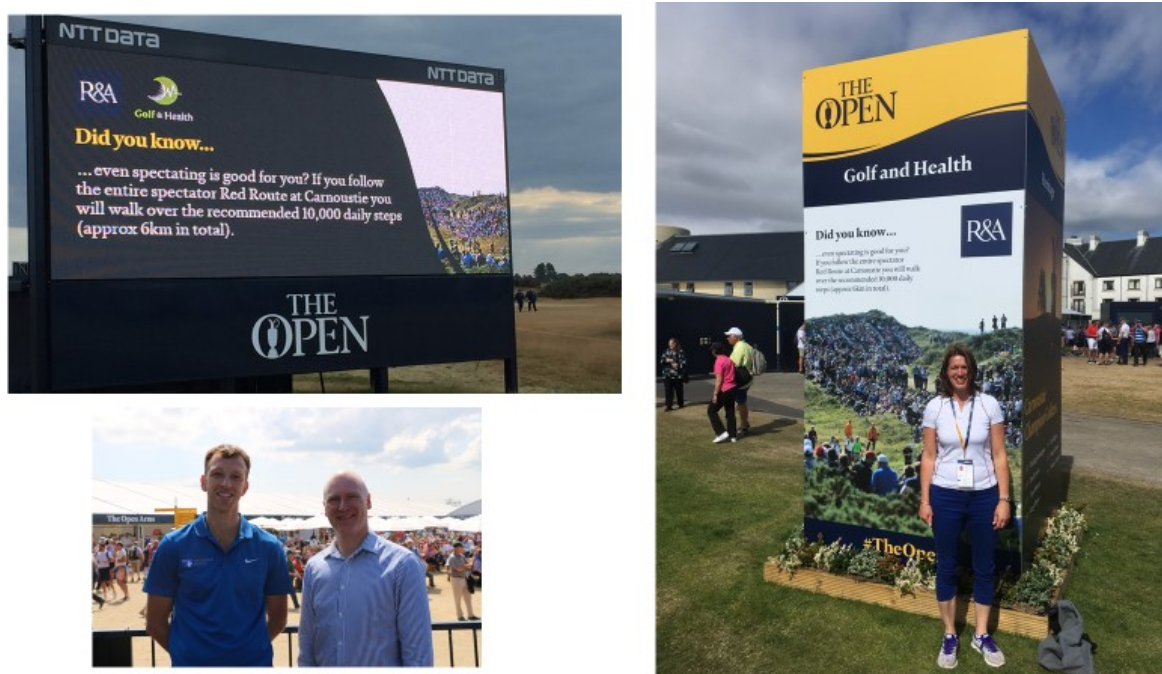


Figure 10. Big screen and information tower content. Pictured being active while spectating themselves are Dr Catherine Calderwood Chief Medical Officer for Scotland; Joe Fitzpatrick, Minister for Public Health and Sport; and Dr Andrew Murray, University of Edinburgh.

3.9 Uptake, use and impact summary

The published paper “Maximising and evaluating the uptake, use and impact of golf and health studies” (Murray, 2019c) and chapter five of this thesis trace the pathway to impact for the golf and spectator health research. Figure 11 below provides an overview of this, providing context for this chapter.

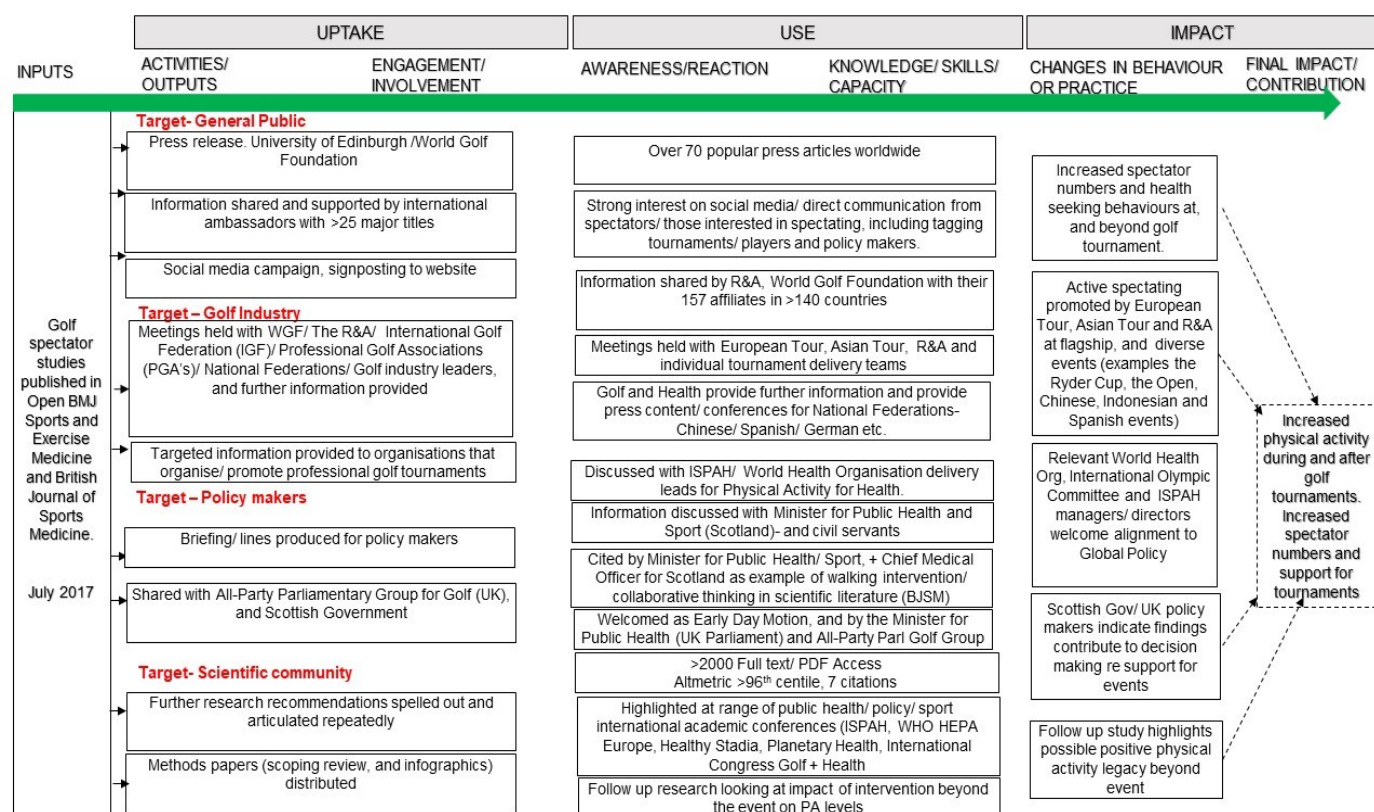


Figure 11. Pathway to Impact of “Golf Spectator Physical Activity” study. Re-produced from Murray, 2019a, with permission from BMJ publishing.

In summary, the spectator health studies have made a contribution to knowledge to end-user groups.

- The general public/ golfers- with >70 popular press outputs, and direct communications indicating golf spectators have changed or are considering changing behaviour based on findings.
- For the golf industry the research has led to the adoption of public health messaging at many of the biggest golf tournaments on earth, and engagement with leading players.
- Public Health/ Sports/ Health ministers and Chief Medical Officers have engaged directly with professional golf tours regarding key messaging and delivery of public health interventions at golf tournaments.

- Scientifically it has been presented at international conferences including ISPAH, WHO HEPA Europe, Planetary Health, Healthy Stadia, the International Congress on Golf and Health, and published in peer reviewed publications.

3.10 Chapter summary and conclusions

The observational study of spectators' step counts and reasons for attending a golf tournament, and follow up study assessing spectators' beliefs and self-reported physical activity 3 months after attending a professional golf tournament were designed to address a key knowledge gap identified by the scoping review.

Findings indicate that obtaining exercise/ physical activity is rated as an important reason for attending a tournament by many golf spectators. Spectating at a golf tournament can provide health enhancing physical activity with 82.9% of those studied at a UK based event obtaining. Public education interventions at golf tournaments may benefit spectators' individual health and well-being and may contribute to public health and well-being having potential to act as a 'teachable moment'.

Recommendations from these research results include:

- Spectators- to spectate in an active fashion, and consider increasing or maintaining physical activity levels beyond the golf tournament
- Golf industry and relevant stakeholders to promote public health interventions and knowledge around physical activity
- Policy makers- can work with promoters to benefit public health by encouraging physical activity and other public health promotion

Following this research I have collaborated with golfers, the golf industry (including event organisers), and policy makers to implement physical activity education/ interventions at major golf events such as the Open Championship, Women's British Open, Ryder Cup, and events in Indonesia, China and Spain.

The most satisfying part of this research was providing clear guidance to spectators, the golf industry and policy makers, and helping implement guidance with these groups to maximise health benefits that can be supported through attendance at a professional golf tournament. Having produced guidance on this relatively narrow aspect of golf and health, the next logical step for this thesis was to produce consensus on what is known about golf and health, with the aim to provide concrete guidance to the public, the golf industry, and policy makers more widely. This consensus process is described in chapter 4.

Chapter Four. An International Consensus on Golf and Health using Delphi methods

4.1 Introduction

4.1.1 Background and rationale

I have presented a review of the literature in chapter two, and original research to address identified knowledge gaps in chapter three. Following these studies, the next objective was to provide guidance on what is known regarding golf and health, and what can be done to promote better health through golf, to i) golfers/ potential golfers ii) the golf industry/ facilities iii) the scientific community iv) policy/ decision makers.

Chapter three describes how research evidence on the health benefits of golf provided scientific guidance to spectators, the golf industry (in particular tournament organisers) and policy makers to guide implementation of health promoting strategies at professional golf tournaments. Having produced guidance on this relatively narrow aspect of golf and health, the next step (as per Figure 12) was to provide concrete advice regarding a wider range of issues, on actions that can be taken to increase opportunities to maximise health gains from golf and minimise health issues related to golf.

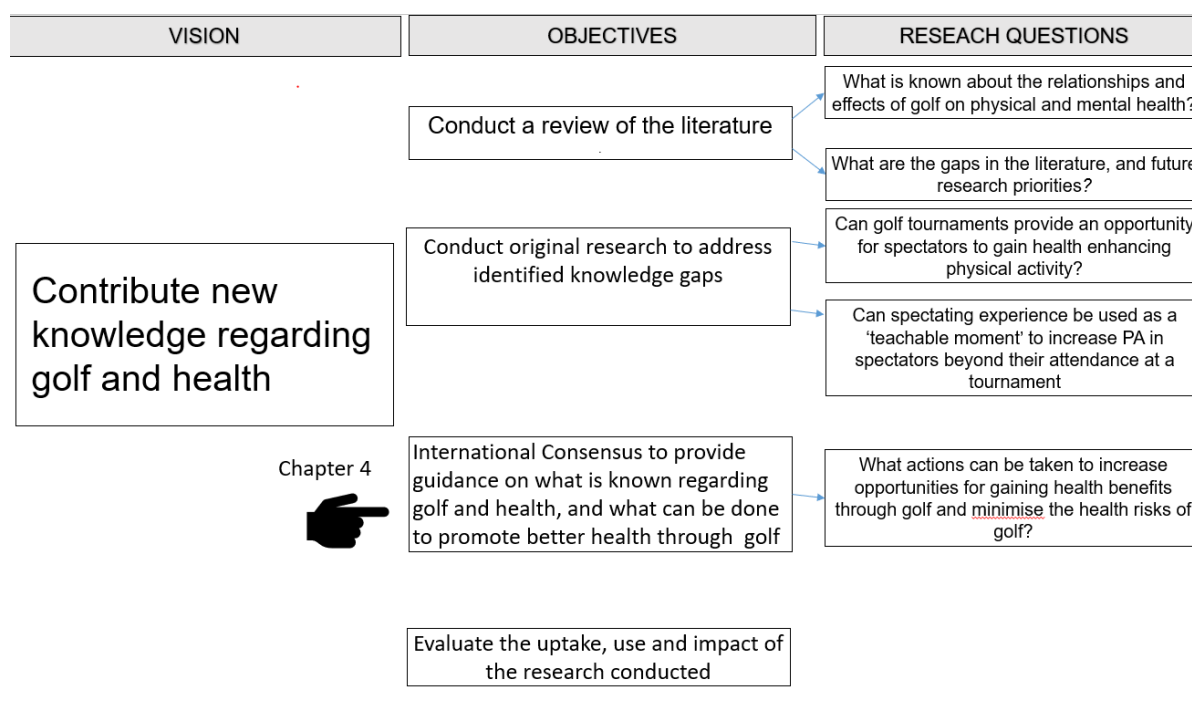


Figure 12. The vision, objectives, and research questions for this thesis, with the objectives and research questions for chapter four highlighted.

The rationale for conducting an International Consensus study on Golf and Health was to provide a consensus on the evidence related to golf and health and provide guidance to golfers, the golf industry, policy makers and the scientific community.

This chapter contains an introduction to the International Consensus on Golf and Health and the processes involved. Following this, two papers published in the British Journal of Sports Medicine (BJSM) are presented. They comprised the consensus itself, and a companion article providing knowledge translation assets which include infographics and video content with the references provided below.

- Murray, A. D., Archibald, D., Murray, I. R., Hawkes, R. A., Foster, C., Barker, K., ... & Mutrie, N. (2018a). 2018 International Consensus Statement on Golf and Health to guide action by people, policymakers and the golf industry. *Br J Sports Med*, 52(22), 1426-14361.
- Murray, A. D., Barton, C. J., Archibald, D., Glover, D., Murray, I. R., Barker, K., & Hawkes, R. A. (2018b). Infographics and digital resources: an International Consensus on Golf and Health. *Br J Sports Med*, 52(22), 1421-1425.

As per previous chapters, word limits of the publishing journal do not permit as thorough discussion as is needed for the purpose of this thesis. Therefore a discussion of the principal findings, strengths and limitations, context and the approach taken to ensure maximal research use, research uptake, and research impact follow the published papers. In order to present the published studies in full, while providing suitable background, some repetition has been needed.

4.1.2. Author contributions

I identified methods, existing literature regarding Delphi methods, and led the development of methods and data extraction. I conducted the Delphi process, and drafted and subsequently revised the consensus. I scripted, and produced digital assets including infographics and animation. Dr Paul Kelly, Professor Nanette Mutrie, and Professor Liz Grant provided supervision in identifying the method. Dr Iain Murray, supported me in identifying existing Delphi methods and frameworks and with data extraction. Dr Danny Glover assisted with the design of the infographics, and Jennifer Duncan and Aston Ward with the animation, video capture and editing.

4.2 Frameworks for consensus statements and protocol

4.2.1 Assessing the need for this work and intended use and impact

Although the scoping review collated evidence on the topic of golf and health, stakeholders wanted to know what was required in terms of specific actions. Providing clarity on actions that could be taken to support golfers/ potential golfers, the golf industry, the scientific community and policy makers could support these groups to make decisions to maximise the health benefits of golf and minimise dis-benefits. It is unlikely that individuals from these groups will have the time or resources to take the scoping review evidence and translate this into meaningful action with knowledge brokering, despite there being much to gain. My assumption was that players, potential players and spectators stand to benefit from a better understanding of how to realise health benefits, and minimise health issues related to golf, while policy makers can raise awareness and support potential public health benefits, and the golf industry can benefit from potential increased interest and participation in the sport.

The uptake, use and impact of our spectator health research (Murray et al., 2017c; Murray et al., 2019b) indicated that clear guidance can contribute to practical implementation in some aspects of golf and health. Key stakeholders including the World Golf Foundation identified that wider guidance through scientific consensus would guide practical implementation much more widely, aiding efforts to improve the health of individuals and populations through golf. Thus I started work to produce an International Consensus on Golf and Health.

4.2.2 Conducting the research

The Delphi method is a systematic, reproducible and established method for achieving consensus of opinion by experts, and identifying priorities on real-world issues (Hsu & Sandford, 2007). These methods can assist in drawing on the best available evidence, and the opinions and experiences of individuals and the organisations they represent (Hasson, Keeney & McKenna, 2000).

Dalkey & Helmer (1963) provided a framework frequently used for Delphi studies. This work has been discussed, utilised and refined by Akins, Tolson & Cole, 2005; Diamond et al., 2014; Gustafson, Delbecq, & Van de Ven, 1986; Hasson et al., 2000; Hsu & Sandford, 2007; and Ludwig, 1997, whose iterations suited their respective applications. These works all describe an iterative series of questionnaires, that allow an expert group to re-score based on the usually anonymised feedback of the group. Delphi methods have been adapted successfully to sport and exercise medicine topics (Crossley et al., 2016; Griffin et al., 2016).

Following discussion with supervisors and Delphi methods experts, I determined to use a series of questionnaires to collect data from the selected expert group (Hsu & Sandford, 2007),

before providing appropriate feedback to the expert panel. Authors report that three iterations or “rounds” are frequently sufficient to collect required information and reach consensus (Hsu & Sandford, 2007; Ludwig, 1997) with 75% agreement being the median threshold agreement to define consensus (Diamond et al., 2014). A Delphi format with use of electronic/ remote collection of data can obviate undue influence of potentially dominant individuals, and lower barriers presented by international travel and communication which can produce bias in a consensus process depending on who can attend and the language they speak. Additionally, the Appraisal of Guidelines for Research and Evaluation 2 (AGREE 2) (Brouwers et al., 2010) instrument was used to inform the conduct of the consensus study.

I led the production of a protocol based on existing best practice for the Delphi method, while ensuring it was suitable and practical for the task in hand. We thus predefined methods and objectives, shown in full at Appendix 13 which we did not significantly deviate from.

4.3 The 2018 International Consensus on Golf and Health

Methods described in the protocol enabled the publication of “The 2018 International Consensus on Golf and health to guide action by people, policy makers and the golf industry” (Murray et al., 2018a).

Further supplementary files, published online only with the consensus are presented in the Appendix to this thesis, as below:

Appendix 14 Consensus statement. Full search strategy.

Appendix 15 Consensus statement. Supplementary file one. Expert panel members.

Appendix 16 Consensus statement. Supplementary file two. Final included statements and levels of agreement.

Permission to publish the consensus and supplementary files within this thesis is granted under the Creative Commons Attribution License (CC BY 4.0; <https://creativecommons.org/licenses/by/4.0/>).

A link to the article and the full article are below.

<https://bjsm.bmj.com/content/52/22/1426>



2018 International Consensus Statement on Golf and Health to guide action by people, policymakers and the golf industry

Andrew D Murray,^{1,2} Daryll Archibald,^{3,4} Iain Robert Murray,⁵ Roger A Hawkes,^{6,7} Charlie Foster,^{8,9} Kevin Barker,¹⁰ Paul Kelly,¹ Liz Grant,¹¹ Nanette Mutrie¹

► Additional material is published online only. To view please visit the journal online (<http://dx.doi.org/10.1136/bjsports-2018-099509>).

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ABSTRACT

Scientific and public interest relating to golf and health has increased recently. Players, potential players, the golf industry and facilities, and decision makers will benefit from a better understanding of how to realise potential health benefits and minimise health issues related to golf. We outline an International Consensus on Golf and Health. A systematic literature review informed the development of a survey. Utilising modified Delphi methods, an expert panel of 25 persons including public health and golf industry leaders, took part in serial surveys providing feedback on suggested items, and proposing new items. Predefined criteria for agreement determined whether each item was included within each survey round and in the final consensus. The working group identified 79 scientifically supportable statement items from literature review and discussions. Twenty-five experts (100%) completed all three rounds of surveys, rating each item, and suggesting modifications and/or new items for inclusion in subsequent surveys. After three rounds, 83 items achieved consensus with each with >75% agreement and <10% disagreement. These items are included in the final International Consensus on Golf and Health. The final consensus presented here can inform scientific knowledge, and action plans for (1) golfers and potential golfers, (2) golf facilities and the golf industry, and (3) policy and decision makers external to golf. These outputs, if widely adopted, will contribute to an improved understanding of golf and health, and aid these groups in making evidence-informed decisions to improve health and well-being.

INTRODUCTION

Recent consensus statements related to sport and health have provided comprehensive, evidence-informed summaries of key issues^{1–3} to help people make informed decisions, and to guide implementation.⁴

Golf is a sport played by over 60 million people on six continents.^{5,6} There has been a recent increase in scientific and public interest relating to golf and health with a decade on decade increase in scientific papers and their uptake.^{7,8} Our 2016 systematically conducted scoping review⁷ and others⁹ have highlighted that golf can provide moderate-intensity physical activity, and may be associated with longevity,¹⁰ physical health^{11,12} and wellness benefits.^{13,14} Conversely, negative health outcomes including injury^{15,16} and an increased risk of skin cancer¹⁷ have been associated with playing golf.

The need for a comprehensive, evidence-informed consensus summary of key issues, and key actions with regard to golf and health was recognised by the World Golf Foundation and its constituent members who are golf's global leaders.

The objectives of this study are:

- To engage leaders at the intersection of health, sport, policy and golf to build a cross-sectoral agreement relating to golf and health.
- To achieve consensus on (1) the health risks and benefits associated with golf, (2) how individuals and populations can improve their health through playing golf or spectating at events, (3) how the golf industry and (4) policymakers can increase opportunities for gaining health benefits through golf and minimise the health risks of golf.

This consensus will enable players, potential players and spectators to benefit from knowledge of how to realise health benefits, and minimise associated health risks related to golf. It will facilitate policymakers to raise awareness and support potential public health interventions, and the golf industry to support education and best practice.

METHODS

The consensus was reached by use of the Delphi method. This is a well-accepted, rigorous and systematic method for achieving consensus of opinion among experts and identifying priorities on real-world issues.¹⁸ These methods can assist in drawing on the best available evidence, and the opinions and experiences of individuals and the organisations they represent. Methods developed by Dalkey and Helmer¹⁹ have been refined and adapted for a range of settings including healthcare, sport and policy.^{20–27} The Appraisal of Guidelines for Research and Evaluation 2²⁸ instrument was used to inform the conduct of this study.

Preliminary work: literature review and framework development

A working group of five individuals with expertise in public health, golf and health, policy, industry and research methods was established to facilitate the Delphi consensus process. Preliminary work was conducted by the working group who updated a 2016 systematic search (screening a further 669 relevant records), and extracting further data as shown in figure 1.^{7,8} Relevant guidelines and policy documents were reviewed, and discussions with authors of primary studies and reviews, and other



► <http://dx.doi.org/10.1136/bjsports-2018-099771>



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leading authorities were conducted where clarification was helpful.

A framework for organising the available evidence for building a golf and health consensus was developed. Each domain/heading was populated with potential items for inclusion in the proposed survey. A draft survey was generated using Survey Monkey (San Mateo, USA), which was assessed for content and form by the working group and three additional researchers with expertise in public health.

Selection of expert panel

To maximise objectivity in expert panel selection, it was determined to invite all 25 contributors to the 2018 International Conference on Golf and Health, a satellite meeting of the International Society of Physical Activity for Health 2018 conference. These individuals had an expertise in one or more of (1) public health/physical activity for health policy, (2) the golf and health subject area, and (3) the golf industry. Potential expert panel members were sent an email introducing the concept, and providing a participant information leaflet. Consent was gained electronically.

Rounds of Delphi survey

Round 1

An initial questionnaire with proposed items for the consensus based on the preliminary work of the working group was circulated to the expert panel. Each was invited to grade each item on a five-point Likert scale²⁹ ('strongly agree', 'agree', 'neither agree nor disagree', 'disagree' and 'strongly disagree'), and to suggest items and make comments that they thought would add value to the next iteration of the questionnaire. It was stated that the level of evidence for items was variable, and that expert panel input was encouraged. The survey results were collated by the working group.

Round 2

The anonymised results from round 1 were fed back to the panel allowing members to appreciate the opinions of others, and the reasons for their position.²⁶

Cut-offs for levels of agreement at each round were defined 'a priori' following working group discussion. In round 1, items scoring >65% agreement (agree or strongly agree) were included in the questionnaire for round 2. In keeping with established practice, modifications to existing items were incorporated by the working group following review of all expert panel comments from survey 1,¹⁸ while additional items suggested during round 1 were discussed by the working group and where agreed added to the questionnaire. The 25 original experts were then invited to take part in a second round survey. Participants were invited to rescore each item on the Likert scale, and provide additional comments.

Subsequent rounds

Items scoring agreement of >75% in round 2 were included for round 3. Final consensus was defined as items scoring agreement (agree or strongly agree) in 75%,^{25 27} and disagreement (disagree or strongly disagree) in <10% of respondents. The survey process was repeated until consensus had been reached (stability of existing items meeting criteria >85% of items)²⁴ and no new items requiring inclusion.

Data analysis

The results of each survey were exported from the Survey Monkey Platform to Excel (Microsoft, Washington, USA). Stacked leaning bar charts (Peltier Tech Advanced V.3.0) were used to present data. A summary of methods is shown in figure 2.

RESULTS AND DISCUSSION

Literature review and framework development

The literature review identified 5605 records. After (1) screening of articles, (2) exclusion of duplicates, (3) further identification of studies through review of references ('snowballing') and (4) consultation with subject area experts, 342 articles had data extracted to inform the proposed International Consensus on Golf and Health.

Review of all data sources and working group discussions generated 79 statements/items emerging from the data which were categorised into three broad domains:

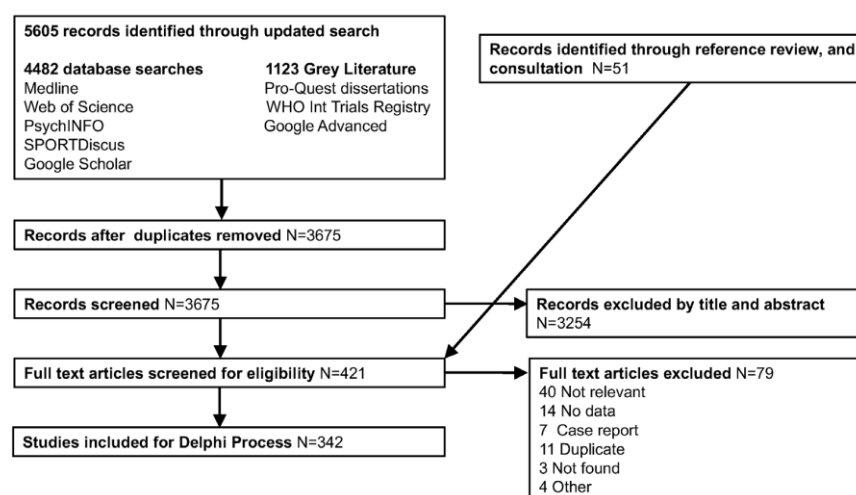


Figure 1 Literature review flow diagram.

Consensus statement

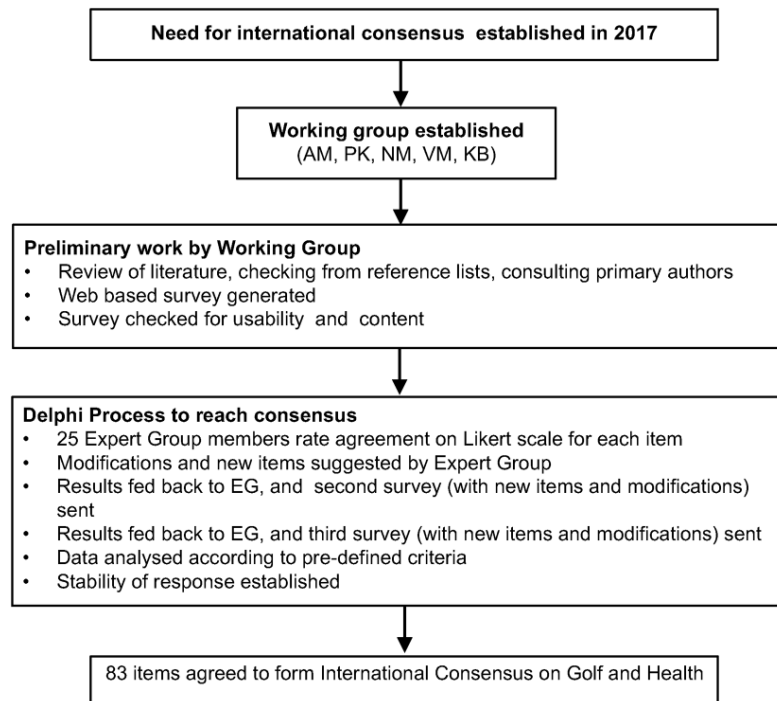


Figure 2 Summary of methods used to develop an International Consensus on Golf and Health. AM, Andrew Murray; EG, expert group; KB, Kevin Barker; NM, Nanette Mutrie; PK, Paul Kelly; VM, Valerie Melvin.

Table 1 A framework for building a golf and health consensus

Domain 1: golf's associations with health and mechanisms			Domain 2: correlates, determinants, diversity and sustainability			Domain 3: interventions/knowledge transfer			
a. Relationship of golf with health outcomes <i>What are the health benefits/disbenefits of golf?</i>	b. Mechanisms to achieve health outcomes <i>How are these benefits developed by golf?</i>	c. Dose and effect <i>What is the intensity and/or volume of golf needed for health benefits?</i>	a. Behavioural patterns <i>Who plays golf? How much do they play golf?</i>	b. Correlators and mediators <i>What helps or hinders participation?</i>	c. Golf and sustainability <i>Impact on sustainability/UNSDG</i>	a. Development and testing <i>What works to promote golf?</i>	b. Actions for golfers <i>How do we maximise health benefits and minimise health risk for golfers?</i>	c. Actions for golf industry/facilities <i>What actions can industry/facilities take to benefit health through golf?</i>	d. Actions for policymakers/decision makers <i>What actions can policymakers/decision makers take to benefit health through golf?</i>

UNSDG, United Nations Sustainable Development Goals.

- Domain 1: Golf's associations with health and potential mechanisms.
 - Domain 2: Correlates, determinants, diversity and sustainability.
 - Domain 3: Interventions and knowledge transfer.
- These were further subcategorised as per [table 1](#).

Establishing consensus using Delphi methods

The results from each round of survey are summarised in [table 2](#). Twenty-five members of the expert group completed each of the three serial surveys within the allocated time frame (a 100% response rate). Following round 1, six new items and 21 modifications were incorporated for survey 2. Following round 2, two new items and 17 modifications were included for round 3. Three iterations or 'rounds' of survey were sufficient to collect the required information and reach consensus by predetermined criteria.^{18 26}

Agreement (defined by >75% 'agree'/'strongly agree' and <10% 'disagree'/'strongly disagree') was achieved for each

and all (100%) of 83 individual items included within survey 3. Across all the items, the mean percentage of expert panel that agreed or strongly agreed with statements was >97%.

Table 2 Summary of results at completion of each survey round in the Delphi process to establish an International Consensus on Golf and Health

Delphi round	Total number of responses (%)	Total number of items included	Number of survey items progressing to next round	Items modified	New items added
1	25 (100)	79	75	21	6
2	25 (100)	81	81	17	2
3	25 (100)	83	83	0	0

A consensus was considered to have been reached if >75% of experts agreed ('agree' or 'strongly agree') and <10% indicated disagreement ('disagree' or 'strongly disagree').

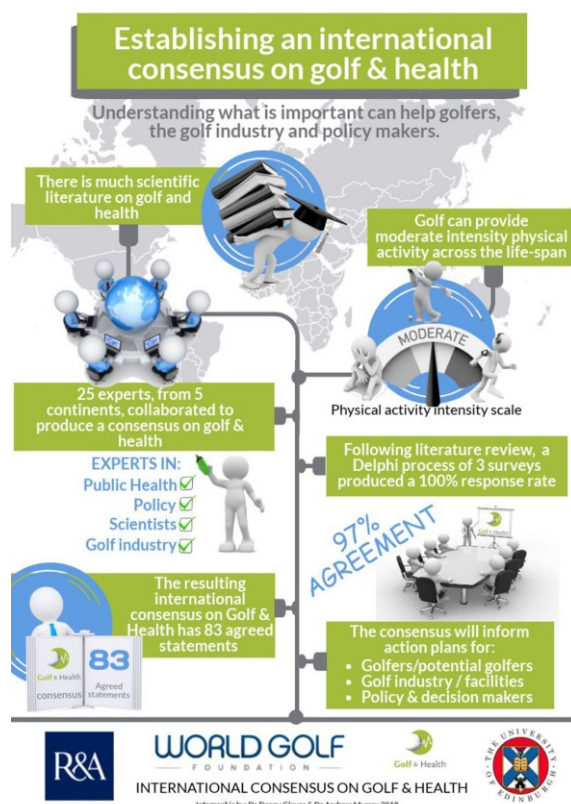


Figure 3 Visual summary of processes establishing an international consensus on golf and health. AM, Andrew Murray; EG, expert group; KB, Kevin Barker; NM, Nanette Mutrie; PK, Paul Kelly; VM, Valerie Melvin.

A summary of processes establishing the consensus are shown in figure 3. All items reaching consensus are shown in table 3, with further detail provided in supplementary file 2.

Summary of consensus

We aimed to establish a consensus on what is known based on the best available scientific evidence and identified 83 items covering three principle domains by Delphi process. The 25 expert panel members provided representation in global public health and sustainability, physical activity for health, health and sport policy, and included clinicians/academics with golf and health subject knowledge. Senior leaders/accountable officers from the World Golf Foundation, The R&A, the European Disabled Golf Foundation, golf facility managers and professional organisations representing golf coaches internationally provided an industry context vital for the building of consensus, but importantly also for the ongoing engagement of stakeholders able to collaborate and deliver evidence-informed decisions and interventions to improve health and well-being in relation to golf.

Three principal domains were identified within the consensus with critical elements discussed below.

Domain 1: golf's associations with health and mechanisms

This domain included 25 statements, with over 90% of the expert panel agreeing with each item. These statements describe health benefits/disbenefits of golf, the mechanisms by which

benefits are achieved, and the volume and intensity of participation needed for these benefits.

Relationships of golf with health outcomes

The best available evidence reports golf can have overall health benefits,^{7 30 31} being associated with increased longevity^{10 32} and improving known risk factors for cardiovascular disease.^{11 12 33 34} Golf is associated with mental well-being benefits,^{31 35-40} and can positively influence health for those with disability.^{31 41} Compared with other sports, the annual risk of injury is moderate,¹⁵ while golfers may be exposed to increased risk of skin cancer.^{7 17} The magnitude of health benefits will depend on many factors including age, gender, genetic factors, and the existing fitness/wellness of the participant, the topography of the course and the frequency of play.⁷ While a significant body of evidence exists relating to golf and health, further high-quality research is needed to assess relationships between golf and mental health, benefits to particular populations, and to explore cause and effect relationships between golf and health.^{7 31 42}

Mechanisms to achieve health outcomes

Golf can provide social interaction,^{38 42-45} health-enhancing physical activity,³³ green exercise and nature connection for persons of all ages,^{31 42 45 46} and specifically can provide moderate-intensity aerobic physical activity.^{7 33} Strength and balance benefits are likely for older adults,⁴⁷⁻⁴⁹ while further research is needed to assess strength and balance benefits for wider populations.⁷ Health benefits are likely greater for those walking the course as opposed to riding a golf cart, although those playing and riding a cart do gain health benefits.^{7 33} Taking part in physical activities additional to golf is likely to offer further health gains.⁵⁰ Spectating in an active fashion (eg, walking the course) at golf courses/tournaments offers an opportunity for health-enhancing physical activity.^{51 52}

Dose and effect

Adults should meet WHO recommendations for physical activity.^{53 54} Participation in golf/other physical activities over and above the minimum guidelines is likely to offer additional benefits.^{7 50} Being physically active/playing golf regularly throughout life provides greater benefits than being active/playing golf intermittently.

Domain 2: correlates, determinants, diversity and sustainability

This domain included 14 statements that describe who plays golf, what helps or hinders participation, and covers sustainability considerations with respect to golf. Knowledge regarding patterns of participation and determinants is critically important in helping maximise interest and participation in a sport with well-accepted overall health benefits. Golf's global leadership including The R&A, and the World Golf Foundation have identified challenges related to sustainability including improving diversity of participation, but opportunities to contribute positively and collaboratively towards the United Nations Sustainable Development Goals 2030.^{31 46 55 56}

Behavioural patterns/participation

Over 60 million people have played golf twice or more in the previous year.⁵ Participation is currently highest in North America, Australasia and Europe, and in men compared with women, in middle-aged and older adults, in some ethnic groups (White-European heritage) and in those of middle and higher socioeconomic class.⁵⁶⁻⁵⁹ Over 20% of adults globally do not meet the WHO Global Recommendations on Physical Activity for Health.^{53 60}

Consensus statement

Table 3 Final consensus statements and levels of agreement

Domain 1: golf's association with health and mechanisms	% Agreement
a. Relationship of golf with health outcomes	
The best available evidence suggests playing golf regularly is associated with increased longevity.	100
Playing golf regularly can improve known risk factors for cardiovascular disease (eg, blood lipids and body composition).	100
As a physical activity, golf is likely to reduce the risk of chronic conditions including cardiovascular disease, type 2 diabetes, colon and breast cancer, depression and dementia.	96
Playing golf is associated with mental well-being benefits which can include improved self-esteem, self-worth, self-efficacy and social connections.	100
Playing/involvement with golf can positively influence health for individuals with disability.	100
Playing golf can contribute to healthy and active ageing, providing physical and mental health, cognitive, social, functional and other benefits.	100
The annual incidence of injury playing golf is moderate compared with other sports, while the risk of injury per hour played is low compared with other sports.	96
Serious injury is rare, although accidental head injury sustained from being struck by a ball or club can have serious consequences.	96
While moderate sun exposure can offer benefits, golfers can be exposed to increased risk of skin cancer associated with excess sun exposure if appropriate care and consideration is not taken.	100
The magnitude of health benefits/health problems will depend on many factors including age, gender, genetic factors and the existing fitness/wellness of the participant, the topography of the course and frequency of play.	100
While a significant body of evidence exists relating to golf and health, further high-quality research is needed.	100
High-quality research is needed to assess relationships between golf and mental health/well-being, the contribution of golf to muscle strength and balance, benefits to particular populations, and to explore cause and effect nature of associations between golf and health.	100
b. Mechanisms to achieve health	
Golf can provide health-enhancing physical activity for persons of all ages.	100
Playing golf can provide moderate-intensity aerobic physical activity.	100
The relative intensity of physical activity while playing golf can vary with topography and length of the course, environmental conditions, and the age, gender and baseline fitness of the participant.	100
Health benefits are likely greater for those walking the course as opposed to riding a golf cart (for those who are able).	100
Benefits accrued by those playing golf riding a golf cart may include health-enhancing physical activity, social connections and green exercise while the intensity of physical activity is lower compared with those playing and walking the course.	92
Playing golf is likely to provide strength and balance benefits for older adults.	100
Spectating in an active fashion (eg, walking the course) at golf courses/tournaments offers an opportunity for health-enhancing physical activity.	100
Playing golf outside can provide a form of green exercise and nature connection which can be enhanced in naturalistic courses.	100
Golf offers opportunities for intergenerational connection, for social interaction and to support communities with events of interest.	100
Taking part in physical activities additional to golf is likely to offer golfers further health benefits.	100
c. Dose and effect	
Adults should do at least 150 min of moderate-intensity aerobic physical activity (which could include golf) throughout the week or do at least 75 min of vigorous-intensity aerobic physical activity throughout the week, or an equivalent combination of moderate and vigorous-intensity activity to meet the WHO recommendations.	100
Participation in golf/other physical activities over and above the minimum physical activity guidelines is likely to offer additional benefits compared with those just reaching the minimum recommendations.	96
Being physically active/playing golf regularly throughout life provides greater benefits than being active/playing golf intermittently.	100
Domain 2: correlates, determinants, diversity and sustainability	% Agreement
a. Behavioural patterns	
Over 20% of adults globally do not meet the WHO Global Recommendations on Physical Activity for Health (WHO figures). Golf is popular in some regions where physical inactivity prevalence is high (North America, Europe, Australasia).	96
Of the over 60 million persons that have played golf at least twice in the previous year, participation is currently highest in North America, Australasia and Europe, in men compared with women, in middle-aged and older adults, in some ethnic groups (White-European heritage) and in those of middle and higher socioeconomic class (The R&A and Sports Marketing Surveys data).	96
b. Correlators and mediators	
There is a need for an inclusive environment within golf that embraces, encourages and welcomes individuals, groups and families from all of society.	100
Some factors that help interest and participation in the sport are that golf can (1) be enjoyable, (2) be played throughout life, (3) offer a sense of community, (4) offer challenge and/or competition, (5) provide outdoor exercise and (6) provide time for self.	96
Golf can also teach life skills, while facilities can provide a social/community hub.	100
Golfers with disability can play equitably with able-bodied golfers or golfers with other types of disabilities at some courses/facilities.	88
Some factors that may hinder interest and participation in the sport include perceptions that it is expensive, less accessible for those from lower socioeconomic groups, male dominated, for older people or difficult to learn.	100
The cost of playing golf can hinder participation in some countries and at some facilities, while other facilities do offer affordable health-enhancing physical activity.	100
Physical proximity to a facility, transport options and playing restrictions can be barriers to participation.	96
Shorter forms of the sport, and efforts to avoid excessively slow play can offset the length of time and offer alternatives to those where time constraints are a barrier to participation.	100
Efforts to provide an infrastructure, social norms and regulations that are welcoming to all can lower barriers to participation.	96

Continued

Table 3 Continued

Domain 2: correlates, determinants, diversity and sustainability	% Agreement
Not everyone will be attracted by the same things at a golf facility, so diversity and specialisation of golf facilities in keeping with the local context, culture and population is appropriate.	88
Aspects that can contribute to people stopping playing golf include: (1) it takes too much time from the family; (2) too expensive; (3) too long to play 18 holes; (4) they tried but did not have fun; (5) too difficult and takes too long to learn; (6) health concerns; and (7) fear of being embarrassed.	96
c. Golf and sustainability	
Golf can promote sustainability through practices that support diversity, healthy societies, environmental integrity and prosperity, and well-being at local and global scale.	100
Domain 3: interventions and knowledge transfer	% Agreement
a. Interventions	
Interventions to make the sport more inclusive and welcoming should be supported.	96
More interventions are required to increase access and participation, building on theories around engagement, enjoyment and including effective monitoring and evaluation aspects.	96
The health benefits of golf will be enhanced by appropriate partnership within and outwith the golf sector (eg, with health or education sector organisations).	100
b. Actions for golfers/participants	
Golfers should aim to play golf at least 150 min/week, or engage in other forms of moderate to vigorous physical activities additional to golf.	100
Golfers should be encouraged to walk the course, as opposed to riding a golf cart to obtain optimal health benefits if able.	100
Golfers should be encouraged to make others feel welcome, and support others to enjoy golf.	100
Golfers should warm up with some aerobic exercise, then golf-specific mobility exercises, then practice swings to maximise performance and minimise injury risk.	100
Golfers should be encouraged to maintain hydration (drinking when thirsty and having fluids available) while on the course, particularly in hot and/or humid conditions.	100
Appropriate strength and conditioning exercises can decrease injury and illness risk, and improve performance.	100
Golfers should use sunscreen and appropriate clothing (collared shirt, hat, and so on) as appropriate, and moderate exposure to direct sunlight.	100
Education should be sought regarding playing safely. Children should be adequately supervised.	100
Spectators at golf tournaments can be encouraged to walk, and spectate in an active fashion.	100
Golfers should follow appropriate lightning safety guidelines, and discontinue play if there is danger from lightning.	96
Golf carts when driven should be done so responsibly, and following local guidance including minimum age requirements.	100
Golfers with cardiovascular disease can play with acceptable safety, but should see a doctor should symptoms increase or be unstable.	96
Golfers can be expected to return to golf following total knee, hip or shoulder replacement, with a graduated return to golf.	100
c. Actions for facilities/the golf industry	
Golf facilities and the golf industry should communicate key actions including those generated in this consensus related to golf and health to players, and potential players in a consistent and engaging fashion, appropriate to their context.	100
Grass-roots initiatives supporting development of golf in regions/countries where golf is a relatively new sport can help encourage growth in these areas.	100
Golf facilities and the golf industry should build on existing initiatives promoting inclusivity, and encourage increased participation, by developing environments and price structures that are welcoming to all.	100
Golf facilities and other golf industry leaders and stakeholders should commit and can work together to develop an environment that will inspire and recruit more women and girls to play golf and retain their participation in the game.	96
Golf facilities and the golf industry should encourage effective learning and coaching environments, and support entry-level play, building on existing initiatives.	96
Golf facilities should consider the preferences of the average golfer when setting up the golf course, for example, length of holes and course, depth and nature of rough, severity of hazards, hole positions, and where necessary make adjustments.	80
Facilities should make every effort to promote equality and diversity, and make golf accessible.	100
Golf facilities where possible should consider being multifunctional (having facilities in addition to golf; eg, gym, walking routes or child care) and having diversity of golf facilities.	88
Golf facilities and the golf industry should promote practices that enhance sustainability—maximising opportunities for wildlife conservation, interaction with green space, restricting water, energy and pesticide/chemical use.	100
Golf facilities should be encouraged to provide information and facilities to support golfers warming up to play.	100
The golf industry/golf facilities should encourage players to walk the course if able, and avoid mandatory golf cart use at facilities.	96
The golf industry/golf facilities can encourage and facilitate regular physical activity and other health-enhancing behaviours (eg, healthy eating).	96
The golf industry should educate and protect employees and golfers about the risks of excess sun exposure.	96
Golf facilities should stock sunscreen, hats and collared shirts.	92
Golf facilities and the golf industry should continue to support health and safety regulations, membership of professional organisations, education relating to safe play, and ensure adequate supervision of children.	96
Golf facilities should consider providing cardiopulmonary resuscitation (CPR) training to staff, and provide automatic external defibrillators.	92
Golf carts should be well maintained, with speed limiters and front wheel brakes.	92
Appropriate lightning safety policies and education should be enacted at each facility. Guidance for appropriate action for players should be highlighted by golf facilities and the golf industry.	96
d. Actions for policy/decision makers (outwith golf sector)	

Continued

Consensus statement

Table 3 Continued

Domain 3: interventions and knowledge transfer	% Agreement
The benefits of regular physical activity including playing golf should be communicated and promoted regularly for persons of all ages, genders and socioeconomic backgrounds.	100
Cross-sectoral policies should be delivered that support the WHO Global Action Plan on Physical Activity, and the United Nations Sustainable Development Goals.	92
Policyholders should be confident golf can provide health-enhancing physical activity to persons of all ages and genders. Policy documents, frameworks and actions should support this.	100
Policyholders should where relevant include golf as a moderate-intensity physical activity in policy documents, guidance and recommendation, and encourage participation for persons of all ages and genders.	100
Policy should support play by diverse geographical and socioeconomic participants of all genders, ages and abilities.	100
Policy documents, frameworks and actions can where relevant usefully acknowledge green space, health and well-being, nature connection, social and community, local and national economic benefits of golf.	96
Policyholders should support efforts to encourage spectators to be physically active (eg, walking the course) at golf and other sporting events.	100
Policies should promote multifunctionality (having facilities in addition to golf) and diversity of facilities where possible, and sustainable practices.	84
Policyholders should work collaboratively with the golf industry and national associations to promote increased participation in physical activity/golf, particularly in groups with low levels of physical activity.	96
Policyholders, governing bodies and the golf industry can work collaboratively to gain acceptance from the International Paralympic Committee that golf be included in the Paralympics.	92

% Agreement is the percentage of expert group members selecting 'agree' or 'strongly agree'.

Sports programmes that encourage participation across the lifespan have been recognised as an approach that can work to positively impact physical activity.^{61 62}

Correlators and mediators

To increase participation in sport, there is a need for an inclusive environment that embraces, encourages and welcomes individuals, groups and families from all of society,^{31 42 46 62} and this is true of golf.^{31 46 56 57} Efforts to provide an infrastructure, social norms and regulations that are welcoming to all can lower barriers to participation.^{31 46 63} Some factors that help interest and participation in the sport are that golf can (1) be enjoyable, (2) be played throughout life, (3) offer a sense of community, (4) offer challenge and/or competition, (5) provide outdoor exercise and (6) provide time for self.^{31 56 57 63} Golf can also teach life skills,⁴⁵ while facilities can provide a social/community hub.³¹

Some factors that may hinder interest and participation in the sport include perceptions that it is expensive, less accessible for those from lower socioeconomic groups, male dominated, a sport for older people, or difficult to learn.^{31 56 63} The cost of playing golf can hinder participation in some countries and at some facilities, while other facilities do offer affordable opportunities. Not everyone will be attracted by the same things at a golf facility, so diversity and specialisation of golf facilities in keeping with the local context, culture and population is appropriate.

Golf and sustainability

Promoting regular physical activity can support the attainment of a number of the United Nations Sustainable Development Goals.⁶⁴ This consensus recognised the importance of supporting international policy^{31 54 55 64} and best practice in this regard. Golf can work to promote sustainability through practices that prioritise diversity, healthy societies, connection with and care of the environment, environmental integrity, and health and well-being.^{31 42 45 46 57}

Domain 3: interventions and knowledge transfer

The third domain contains 42 individual items, highlighting its fundamental importance. This section explores what interventions work in promoting golf, and what can practically and feasibly be done to maximise health benefits and minimise

health risks associated with golf. The weight of evidence is generally weaker than for other categories, with some recommendations based on consensus of opinion. Practical actions, building on existing progress, can help increase physical activity.^{61 62 63}

Included are 13 actions for golfers/potential participants, 18 actions for golf facilities/the golf industry and 10 actions for policy/decision makers external to the golf industry that if widely disseminated and adopted will contribute to an improved understanding of golf and health, and aid these groups in making evidence-informed, more consistent decisions and interventions to improve health and well-being. Representatives from these groups have been key in making these recommendations. These are summarised in the section below, and in table 3. Bite-sized assets (infographics, podcast and video; Murray AD, Infographics and digital resources. An international consensus on gold and health. Under peer review) for golfers, the golf industry and facilities, and policy/decision makers have been produced to facilitate uptake by these groups.

Interventions

Appropriate partnerships within, and outwith the sport sector can support interventions to make the sport more inclusive and welcoming.^{31 42 45 46 57} Interventions are required to increase access and participation, building on theories around engagement, enjoyment, and including effective monitoring and evaluation aspects.

Actions for golfers/participants

Golfers should aim to play golf at least 150 min/week,^{7 53} or engage in other forms of moderate to vigorous physical activities additional to golf. Golfers can be encouraged to walk the course, as opposed to riding a golf cart if able.^{7 66} Warming up with some aerobic exercise (eg, stair climbing or stationary bike), then golf-specific mobility exercises, then practice swings can help maximise performance and minimise injury risk, as can appropriate strength and conditioning.^{67 68} Golfers should be encouraged to make others feel welcome, and support others to enjoy golf.^{31 42} Spectators at golf tournaments can be encouraged to walk, and spectate in an active fashion.

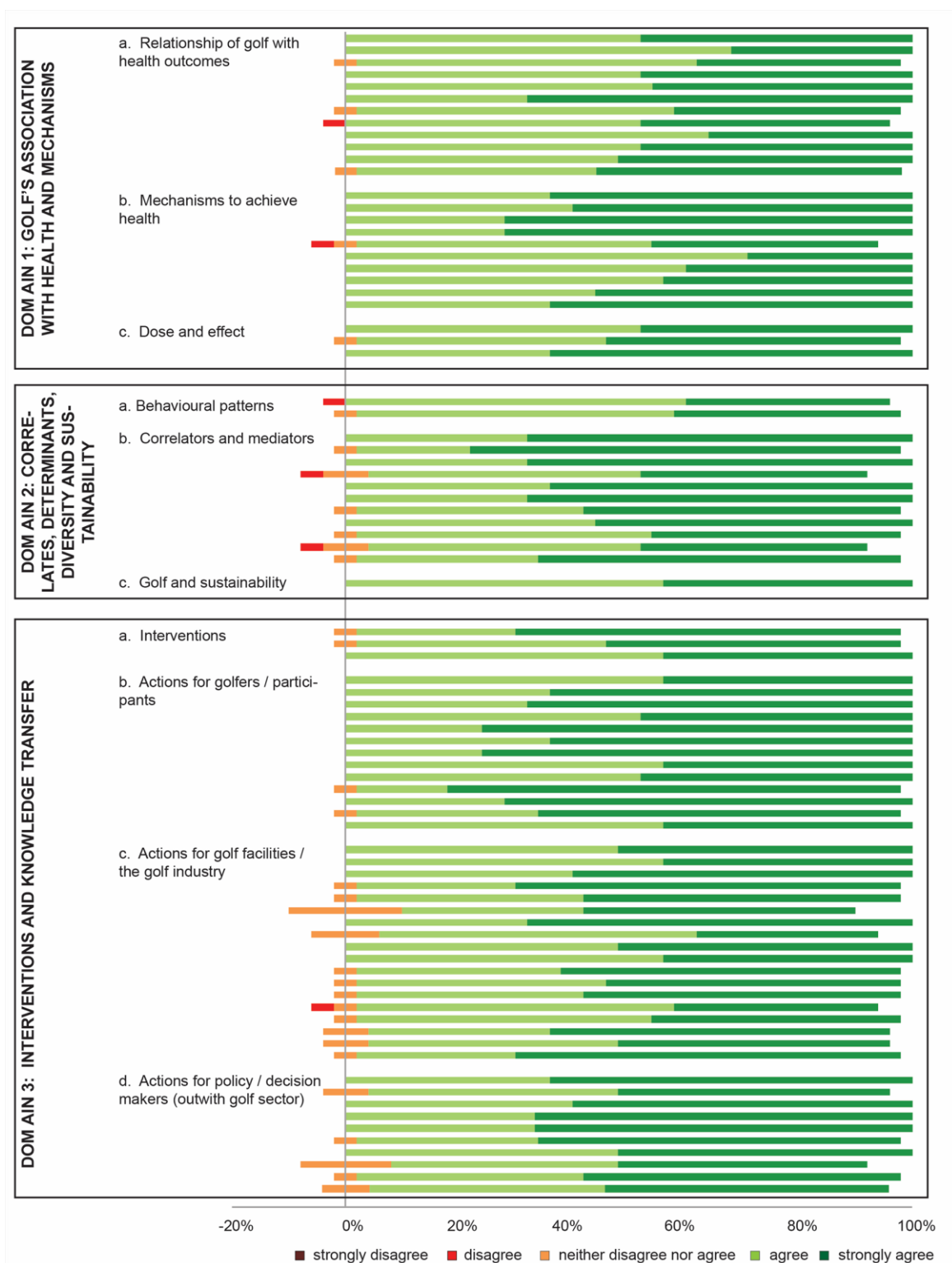


Figure 4 Stacked leaning bar graph showing level of agreement for each item for survey 3.

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To minimise health risks, golfers should follow appropriate lightning⁶⁹ and golf cart safety guidelines.⁷⁰ Golfers should use sunscreen and appropriate clothing (collared shirt, hat, and so on) as appropriate,⁷¹ and moderate exposure to direct sunlight.⁷² Children should be adequately supervised.⁷ Golfers with cardiovascular disease can play with acceptable safety, but should see a doctor should symptoms increase or be unstable.⁷ Golfers can be expected to return to golf following total knee, hip or shoulder replacement, with a graduated return to golf.⁷³

Actions for golf facilities/the golf industry

Recommendations are presented for golf facilities and the golf industry. The World Golf Foundation and The R&A who lead golf development activity globally are committed to working with a range of stakeholders to deliver and support key actions related to golf and health, and communicate key actions to the 60 million golfers worldwide.

Grass-roots initiatives supporting development of golf in regions/countries where golf is a relatively new sport can help encourage growth in these areas.^{6 45 56} Golf facilities and the golf industry should build on existing initiatives promoting inclusivity, and encourage increased participation by developing environments and price structures that are welcoming to all.^{31 42 45 57} The golf industry/golf facilities can encourage and facilitate regular physical activity, other health-enhancing behaviours (eg, healthy eating), and counsel about the dangers of excessive sun exposure. Practices that enhance sustainability, including maximising opportunities for wildlife conservation, interaction with green space, restricting water, energy and pesticide/chemical use, should be encouraged.^{42 56}

Golf facilities and other golf industry leaders and stakeholders can commit and can work together to develop an environment that will inspire and recruit more women and girls to play golf, and retain their participation in the game.^{46 56} Effective learning and coaching environments, and entry-level play, can be further encouraged, with facilities considering the preferences of the average golfer.⁶³ Facilities should make every effort to promote equality and diversity, and make golf accessible and environmentally sustainable.⁴² Facilities should consider being multifunctional (having facilities in addition to golf; eg, gym, walking routes or child care) and having diversity of golf facilities.⁴²

Further, facilities should be encouraged to:

1. Provide information and facilities to support golfers warming up to play.
2. Stock sunscreen, hats and collared shirts, healthy food and water.⁷¹
3. Consider providing cardiopulmonary resuscitation training to staff, and provide automatic external defibrillators.⁷
4. Adequately maintain golf carts with speed limiters and front wheel brakes.
5. Provide appropriate lightning safety policies.

Actions for policy/decision makers (outwith the golf sector)

Decision makers at community/municipal, local, national and international levels have engaged in discussions which informed this consensus, and future delivery of plans. This consensus has considerable alignment with the WHO Global Action Plan on Physical Activity,⁵⁴ and the United Nations Sustainable Development Goals.⁵⁵ Further cross-sectoral collaboration can further support these global efforts. Policymakers can work collaboratively with the golf industry and national associations/federations to promote increased participation in physical activity/golf, particularly in groups with low levels of physical activity (eg, older adults).

The benefits of regular physical activity including playing golf should be communicated and promoted regularly for persons of all ages, genders and socioeconomic backgrounds. Golf can be included as a moderate-intensity^{7 33} physical activity in policy documents, guidance and recommendations, and participation encouraged for persons of all ages and genders. Policy documents, frameworks and actions can, where relevant, usefully acknowledge green space, health and well-being, nature connection, social and community, and local and national economic benefits of golf.³¹ These policies should support play by diverse geographical and socioeconomic participants, of all genders, ages and abilities, multifunctionality of facilities and sustainability considerations.

Strengths and limitations of present study

Strengths of the present study include the systematic nature of the literature review, and a 100% response rate from experts identified as leaders across public health/physical activity for health policy, the golf industry, and the golf and health subject area. Recommended standards for the conduct of Delphi studies were followed.²⁷ This engagement in coproducing this consensus will aid collaboration in delivering the interventions and action plans that can maximise the impact of this work. We used objective criteria for expert panel selection. The level of agreement for inclusion within the consensus was high, and the threshold for excluding items low, important given the engagement with the golf industry and potential conflict of interest.

Although the search was conducted systematically, using established scoping review methodology,^{74 75} and some quality assessment was carried out, formal and systematic quality assessment of each study was not conducted due to the large range of subjects to be covered. The items are based on the best available evidence, and that in many cases further and more definitive research is needed. Statements contain some element of repetition, which was considered necessary by the working group for the consensus, and action plans by relevant stakeholders to be comprehensive. As evidence and practice evolves, the consensus will require revisiting and updating.

CONCLUSION

Our study has produced one of the first wide-ranging global consensus statements for a sport, and engaged leaders at the intersection of health, sport, policy and golf to build this cross-sectoral agreement. Consensus was achieved showing health benefits and health risks that golf is associated with, and highlighting actions by which (1) individuals and populations can improve their health through playing golf, and (2) how the golf industry/facilities and (3) policymakers can increase opportunities to gain health benefits through golf and minimise any health risks associated with golf. These outputs, if widely shared and adopted, will contribute to an improved understanding of golf and health, and aid these groups in making evidence-informed decisions and to improve health and well-being. A stacked leaning bar graph showing level of agreement for each item for survey 3 is shown in figure 4.

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Contributors ADM, DA, PK, LG, IRM and NM identified the method and existing Delphi frameworks to develop this study. ADM and IRM conducted the updated search and data extraction. All authors contributed to the development of outline study design and the conduct of the study.

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4.4 Efforts to encourage visibility, uptake, use, and impact

4.4.1 Introduction

The over-arching **vision** for this thesis was to contribute knowledge regarding what is known about golf and health, and what can be advised to maximise health benefits, and minimise the health dis-benefits of golf.

In this chapter I aimed to contribute knowledge to i) golfers, golf spectators and the general public, ii) the golf industry/ facilities, iii) the scientific community, iv) policy/ decision makers, and recognised that the full scientific paper may need to put in accessible form for each of these groups. This speaks to the importance for scientists and academic institutions of engaging stakeholders (Best & Holmes, 2010; Morton, 2015a), and developing engaging content that can be shared widely (Barton & Merolli, 2017; Murray, Duncan, Glover, Griffin, & Tarazi, 2019a; Murray, Murray & Barton, 2018c). I detail efforts to maximise uptake, use and impact of research further in chapter five.

4.4.2 Creating communication content - Infographic and digital resources

To ensure infographic content was scientifically robust, I worked with my academic supervisors to draft and submit a short paper including infographics and digital resources for peer review. A key difference between this paper, and the infographics published in chapters two and three is that it is more comprehensive. While chapters two and three contained single summary infographics related to i) golf and health and ii) golf and spectators health, “infographics and digital resources for the international consensus on golf and health” contains three infographics and supporting text. Each infographic summarises key actions that could improve health through golf for a key stakeholder group. As each of these groups, and actions required were distinct, a separate infographic for each group could add value, providing clear messaging in an engaging format. “Infographics and digital resources for the international consensus on golf and health” was published in the British Journal of Sports Medicine and is reproduced within this thesis granted under the Creative Commons Attribution License (CC BY 4.0; <https://creativecommons.org/licenses/by/4.0/>). A link to the article is shown here <https://bjsm.bmj.com/content/52/22/1421>

The full article is presented below

Infographics and digital resources: an international consensus on golf and health

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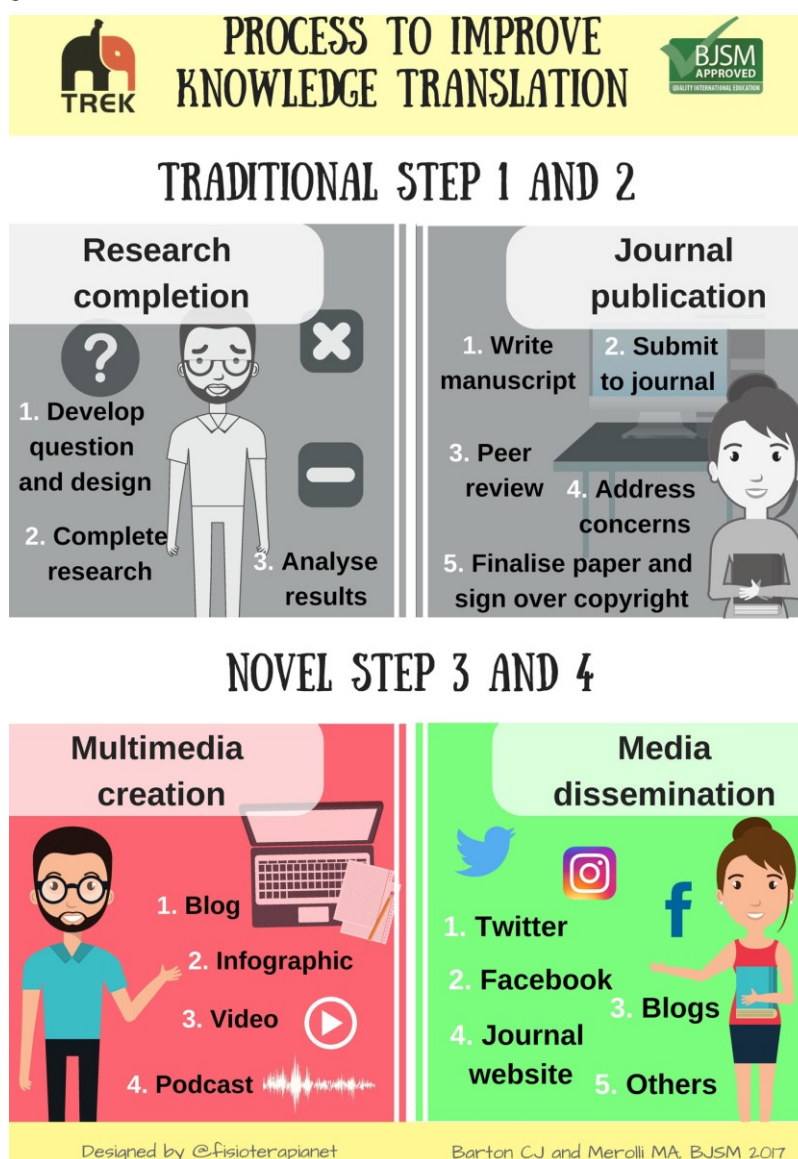


Figure 1 Visual representation of a process to improve knowledge translation based on Barton and Merolli's model.²

INTRODUCTION

New knowledge from research findings rarely produces rapid efficient changes in practice.¹ Barton and Merolli² proposed a model which may help improve knowledge translation via the addition of two novel contemporary steps: multimedia

creation and subsequent dissemination (see figure 1).

Following this model, we recently produced digital/multimedia resources to help communicate and disseminate the International Consensus on Golf and Health.³

RESEARCH COMPLETION AND PUBLICATION

A systematic literature review and modified Delphi process underpinned the International Consensus on Golf and Health and this was published in the *British Journal of Sports Medicine* in 2018.³ The

Infographics

Consensus is intended to support (1) golfers and potential golfers; (2) golf facilities and the golf industry; and (3) policy makers to make evidence-informed decisions that can maximise the health benefits of golf and minimise the health risks associated with this sport.

MULTIMEDIA CREATION

Articles containing visual information are read three times more often than those without.⁴ Humans remember up to 6.5

times more through learning from visual imagery than by reading text alone.⁵ This makes sense. How many text-only adverts do you see? What is your reaction to a wordy PowerPoint presentation? We produced bite-sized resources (infographics, podcasts and video content) with the key messages stemming from the consensus statement.³

Infographics have been made to support end-user groups: (1) golf players/potential players; (2) the golf industry/facilities; and

(ii) policy makers external to golf. These visual resources highlight the specific actions that can lead to the biggest gains in health and well-being related to golf (see figures 2–4). They complement published infographics regarding golf and health⁶ and maximising golf performance.⁷

Video content was designed to have broad interest. We featured leading players who had won multiple major championships as well as researchers, clinicians and public health ministers. These are available



Figure 2 Infographic. Tips to maximise health benefits of golf for golfers.

WHAT CAN THE GOLF INDUSTRY/FACILITIES DO TO MAXIMISE THE HEALTH BENEFITS OF GOLF?



Figure 3 Infographic. What can the golf industry/golf facilities do to maximise the health benefits of golf?.

at www.golfandhealth.org. A podcast with more detail discussing the International Consensus on Golf and Health is available at <https://soundcloud.com/bmjpodcasts/sets/bj-sm-1>. It offers researchers and others interested a 'deeper dive' into the methods and findings.

DISSEMINATION AND COMMUNICATION

Infographics and other multimedia/digital resources facilitate the sharing of key messages and engagement with research.

They are not a substitute for reading the detailed peer reviewed article. Strategies⁸ for sharing content can include:

- ▶ social media platforms (eg, via Twitter, Facebook, Instagram and blogs)
- ▶ email, plus or minus press release distribution
- ▶ direct communications including discussions, meetings and presentations targeting relevant stakeholders.

We used these strategies to share our previous scoping review on golf and

health.⁹ This approach to sharing new research may have contributed to this manuscript being the subject of over 90 press articles, a supportive Early Day Motion in the UK parliament and achieving an Altmetric score >1300.

CONCLUSION

Barton and Merolli's model offer researchers strategies to increase the visibility of their work. After conducting an International Consensus on Golf and Health and publishing it in the BJSM, we



Figure 4 Infographic. Golf and Health: key actions for policy/decision makers.

shared bite-sized multimedia resources to assist the dissemination and communication of the consensus. The BJSM is well positioned to support researchers who wish to produce similar digital resources. Options include, but are not limited to, co-producing podcast and blog content, and sharing purpose-created digital resources via popular Twitter, Facebook, Instagram and YouTube platforms.

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Contributors ADM, CJB, IRM, DA and RAH identified the framework and wrote the text. ADM, DG and KB produced and refined the digital assets. All authors commented on drafts and contributed to the development of the final manuscript and assets.

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4.5 Principal findings and context

The International Consensus Statement on golf and health provides guidance on actions by people, policy makers and the golf industry. The principal research findings were:

- It was feasible to engage leaders at the intersection of health, sport, policy and golf to build a cross-sectoral agreement relating to golf and health.
- Consensus was achieved on i) the health risks and benefits associated with golf, ii) how individuals and populations can improve their health through playing golf or spectating at events iii) how the golf industry, and iv) policy makers can increase opportunities for gaining health benefits through golf and minimise the health risks of golf.
- Working with key stakeholders, including golfers, the golf industry, policy makers, public health experts and colleague researchers was vital in establishing consensus, and for practical implementation beyond this.

It was encouraging that leaders at the intersection of health, sport, policy and golf could collaborate to produce a cross-sectoral consensus relating to golf and health. Consensus has been reached by practitioners, researchers and industry before regarding the epidemiology and reporting of illness/ injury in tennis (Pluim et al., 2009), football (Fuller et al., 2006), rugby union (Fuller et al., 2007), rugby league (King, Gabbett, Gissane, & Hodgson, 2009), multi-sport (Junge et al., 2008), cricket (Orchard et al., 2016), athletics (Timpka et al., 2014), and thoroughbred horse racing (Turner et al., 2012), but not to our knowledge regarding the public health aspects of a particular sport.

A memorandum of understanding signed in 2010

https://www.who.int/dietphysicalactivity/mou_olympicscommitte_en.pdf?ua=1 and renewed in 2018 between the International Olympic Committee (IOC) and the World Health Organisation calls for the promotion of healthy lifestyles, physical activity and sport. An opportunity exists for each sport to engage leaders in their sport, and work with researchers, policy makers and other stakeholders to evaluate the evidence and reach consensus on how health benefits can be maximized and health dis-benefits minimized. This can help support the aim of the World Health Organisation to support more people to be more physically active, more often (World Health Organisation, 2019). The illness/ injury epidemiology and reporting consensus documents also offer insight that sports can learn and build on templates from other sports in building agreement to guide action and inform interventions and evaluation.

Direct communications with researchers and practitioners in other sports affirms the value of close co-operation and collaboration with industry and policy makers, and in learning from the experiences of other sports in building consensus and guiding practical implementation.

Overall, working on the golf and health consensus helped further golf and health knowledge, and can inform the approach of other sports.

4.6 Strengths and limitations

Strengths and limitation of the consensus study are discussed within the published papers. In short, established search strategy and Delphi methods were utilized building on my previous work and established best practice. I minimized bias due to conflict of interest by requiring high levels of overall agreement for a statement to be included in the final consensus.

The consensus re-emphasized that better, more definitive research is needed in some areas, including

- i) golf's role in providing muscle/bone strengthening, and balance improvement benefits,
- ii) evaluation of the implementation of recommendations that can improve health for people and populations, and mitigate health dis-benefits associated with golf.
- iii) Mental health and well-being and golf in specific population groups (for example women and girls, and those with a disability).

A significant strength of the process was building a network of researchers, practitioners, golf industry experts, and policy makers. Once the consensus was agreed, this established network was able to progress and co-deliver aspects of the consensus.

As highlighted in the published papers, knowledge gaps existed, and the consensus is based on the best available rather than consistently strong evidence. With these knowledge gaps being addressed re-visiting the evidence and updating the consensus would be merited.

4.7 Uptake, use and impact summary

I created content subject to scientific peer review, but also additional multi-media/ digital assets to help sharing of key messages and engagement with the consensus. Creating this content is a key step in being able to share research findings and make them relevant to different stakeholder groups (Barton & Merolli, 2017; Ibrahim et al., 2017; Murray et al., 2018c). I then worked with relevant stakeholders to share research findings widely. Below are examples of work to share research findings with the stakeholder groups identified previously.

Golfers/ general population.

The publishing journal (BJSM) issued a press release, with information shared with general and golf press. I was available for and took part in interviews for television, radio, newspapers, online content and industry press. We created an entire section of the golf and health website providing content from the consensus <https://www.golfandhealth.org/about/international-consensus-on-golf-health/> . Social media platforms (twitter, Facebook, Instagram and blogs) shared these resources, and gathered feedback/ user experience.

Golf Industry

Summary briefings were created for golf industry leaders, who were tasked with sharing findings with golf facilities and the golf industry. The World Golf Foundation and R&A communicated findings with each national federation, and the leading organisations that represent the executive board of the World Golf Foundation.

Policy Makers

Publication of the International Consensus on Golf and Health followed shortly after the launch of the World Health Organisation's Global Action Plan on Physical Activity. An example of dialogue I facilitated included a reception at the UK Houses of Parliament, where parliamentarians and other delegates heard from

- World Health Organisation's Program Manager Prof Fiona Bull, on the Global Action Plan for Physical Activity
- International Consensus on Golf and Health first author Dr Andrew Murray regards actions policy makers can take regarding physical activity, golf and health
- The R&A Chief Executive Martin Slumbers described efforts to make golf more inclusive, accessible and outlined the Women and Girls charter
- Steve Brine the Minister of Public Health and Sport reflected on golf's overall health

benefits, and how collective action can best maximise these.

We responded to requests from policy makers/ decision makers in several countries requesting detail of actions for policy makers.

Scientific Community

An International Congress on Golf and Health (17-18th October 2018) coincided with the release of the consensus document. This featured a full day Golf and Health scientific meeting with researchers and interested parties from the USA, Australia, China, Lithuania and the UK who considered the findings of the consensus and discussed research they are undertaking in the fields of dementia and Parkinson's Disease, social prescribing, rehabilitation of military veterans, golfer engagement, physical activity. This facilitated streamlining of ideas and further collaborative working. A 40 minute breakfast meeting was hosted the day prior during the International Society for Physical Activity for Health (ISPAH) bi-yearly congress.

In chapters two and three we utilised the Research Contribution Framework (Morton, 2015a, b) to evaluate the uptake, use and impact of i) the scoping review and ii) spectator health research. These research outputs had been published for over a year prior to evaluation.

The published paper "Maximising and evaluating the uptake, use and impact of golf and health studies" (Murray, 2019c) and chapter five of this thesis trace the pathway to impact for the International Consensus on Golf and Health and other golf and health publications. Figure 13 provides an overview of this, providing context for this chapter. As before, we describe a pathway/ contribution to impact, acknowledging that other factors can contribute to outcomes. The timeframe (six months) between publication of the consensus, and the evaluation process was short, meaning that eventual impact is still to be determined.

In summary, the International Consensus on Golf and Health has made a contribution to knowledge, to end-user groups including

- The general public/ golfers- with >120 popular press outputs, and direct communications indicating golfers are taking action based on it.
- For the golf industry the consensus has been discussed with senior leaders from all seven organisations represented on the board of the World Golf Foundation. A contribution to increasing inclusivity of golf can be demonstrated.
- For policy makers it has been discussed with nine government ministers, some of whom have facilitated cross-sectoral discussion, and are signatory to the consensus.

- Scientifically, the process of producing consensus has helped shape the research and implementation agenda, while a major international meeting brought researchers from 4 continents together to consider next steps.

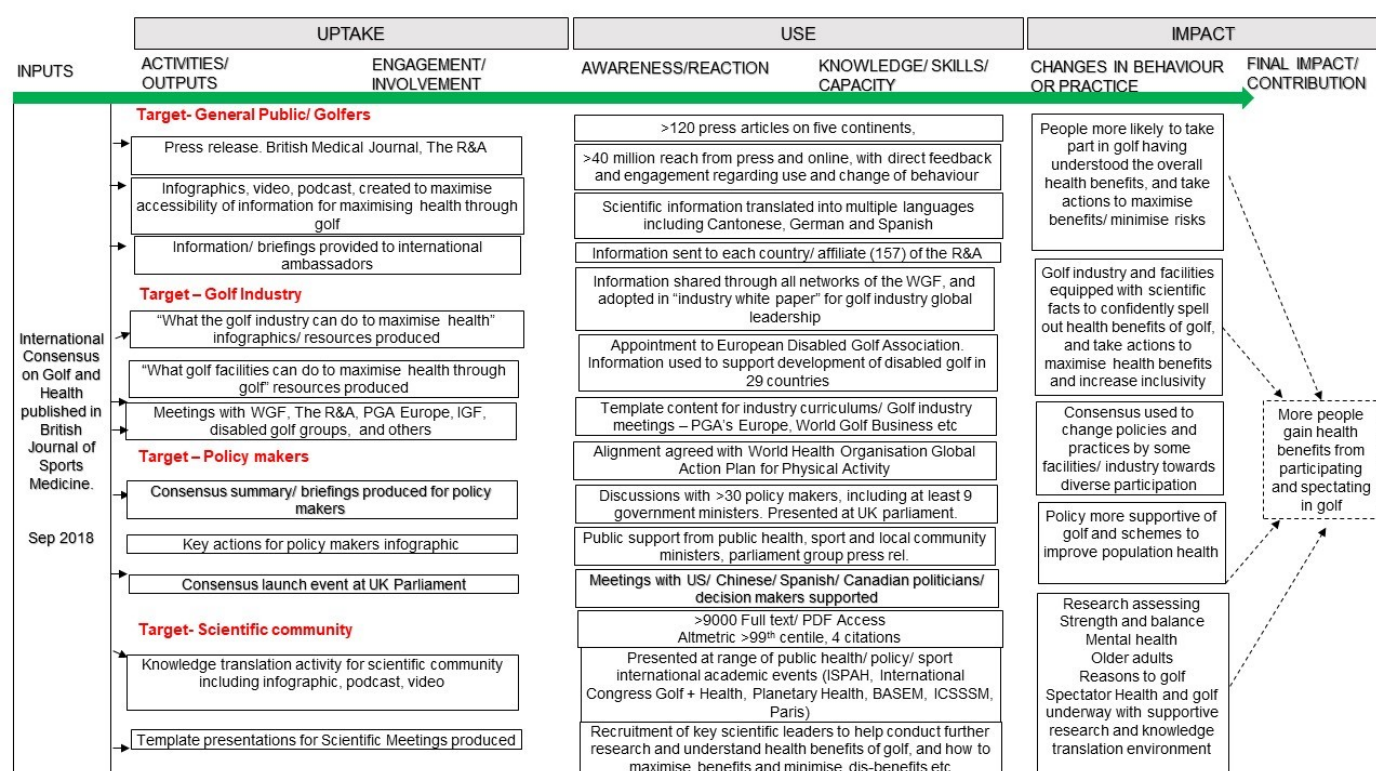


Figure 13. Pathway to impact of International Consensus on Golf and Health. Re-produced from Murray, 2019a, with permission from BMJ publishing.

4.8 Chapter summary and conclusions

The “2018 International Consensus Statement on golf and health to guide action by people, policy makers and the golf industry” was designed to provide information to key stakeholder groups namely:

- i) Golfers/ potential golfers
- ii) The golf industry/ facilities
- iii) Policy/ decision makers

Providing specific guidance to these groups built on chapters two and three which had systematically reviewed the literature regarding golf and health, and conducted original research to address a knowledge gap.

Experts in health and sport policy, global public health, golf and health, and clinicians with relevant subject knowledge were represented amongst 25 expert panel members involved with the Delphi process. 83 items covering three principle domains were included in the final consensus. Having a breadth of stakeholders involved in building the consensus was valuable in ensuring wide relevance, and potentially for practical implementation beyond this.

Following the conduct of i) the Scoping Review ii) original research addressing a knowledge gap and iii) an International Consensus Statement on golf and health to guide action by people, policy makers and the golf industry, an evaluation was designed to examine the uptake, use and impact of this research. This is the focus of chapter five.

Chapter Five- Knowledge Translation and Impact Assessment.

5.1 Introduction

5.1.1 Rationale and background

As previously stated, I wanted to understand how my research could make a difference in the real world, and to evaluate the success or otherwise of the project in achieving the vision/ objectives. This was for a number of reasons. Having come from a background working in public health policy (with the Scottish Government) and as a General Practitioner/ Family doctor, I had come to understand the importance of getting research into practice. As well as producing empirical evidence on golf and health, I wanted to provide evidence on how this knowledge can be used. I also recognised that the communication and dissemination of research, and evaluation of its uptake, use and impact is also a growing priority for both researchers and funders (Higher Education Funding Council for England, 2014, 2017; The UK Economic & Social Research Council, 2015). Mechanisms to support the implementation of priorities identified from physical activity research and policy documents remains a key challenge (Koorts, Eakin, Estabrooks, Timperio., Salmon, & Bauman, 2018), and I wanted to contribute to this knowledge gap.

Thus, further objectives for this thesis were to i) maximise the impact of our work and ii) perform an evaluation, to determine to what extent uptake, use and impact of this research had been achieved. In this chapter, I take the topic of golf and health and aim to outline processes that may contribute to improved research uptake, use and impact proposing a Research Impact (RI) tool. I then evaluate my published research using the Research Contribution Framework (RCF). Figure 14 below highlights the overall vision for the thesis, the objectives, and the research questions that stem from these. This includes the research question “what is the uptake, use and impact of the research conducted within this thesis”.

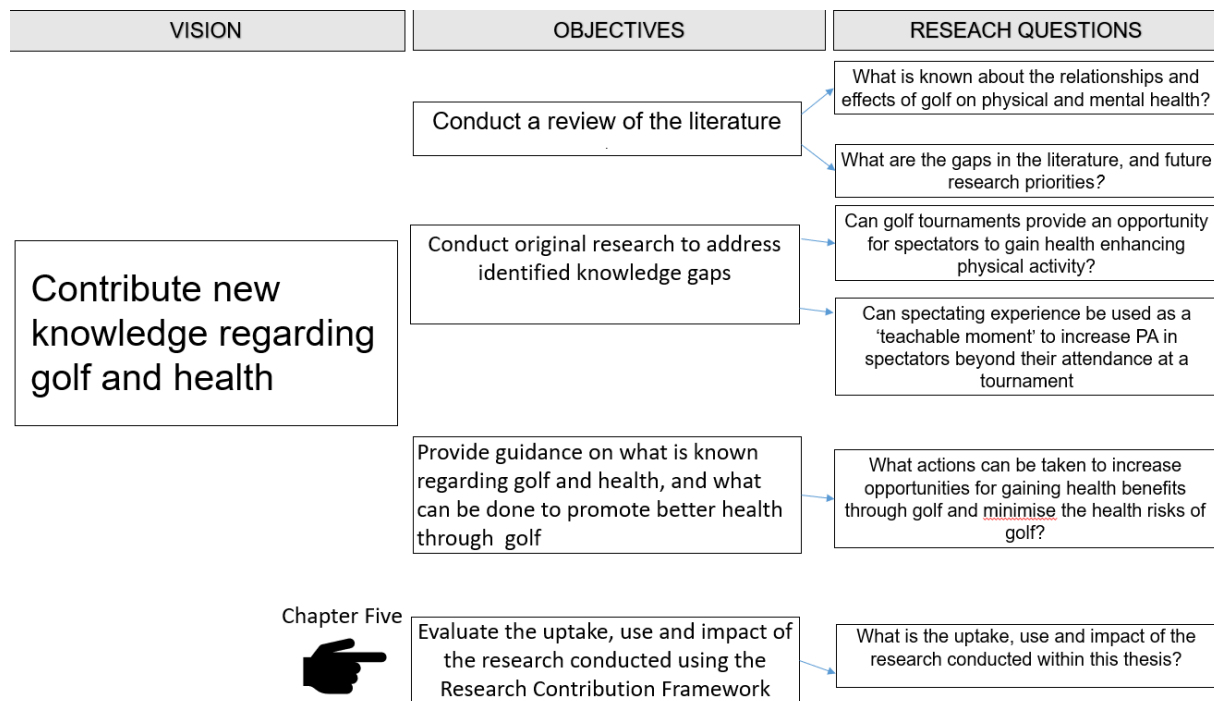


Figure 14. The vision, objectives, and research questions for this thesis including objectives and research questions for chapter five

5.1.2 Maximising the impact of the research

Prior to starting my PhD, my main involvement with research was as an end user in my roles as a practitioner (General Practitioner and Sports and Exercise Medicine Consultant), and policy maker. I had been amazed by the failure of knowledge (for example research findings) to be applied consistently in clinical practice and policy, neatly described as the “know-do” gap in a World Health Organisation (2006) publication. Don Berwick the Chief Executive Officer of the Institute for Health Improvement (IHI) outlined in a speech in 2003 that

“The failure to use available science is costly and harmful; it leads to over-use of unhelpful care, under-use of effective care, and failures in execution”

There are numerous examples of failure of knowledge to be executed in public health policy and practice, with for example citrus being shown to be effective against scurvy by James Lancaster in 1601, and again by James Lind in 1753, but the British Navy taking until 1795 to adopt policies encouraging citrus fruit consumption to prevent scurvy (Glouberman, 2009).

While learning how to become a better and more professional researcher during the conduct of my thesis, I also wanted to better understand knowledge exchange, and mechanisms by which research could be impactful; a quality increasingly prioritised by researchers,

universities, and Research Frameworks (Higher Education Funding Council England, 2014, 2017; Stern, 2016). This would allow the research produced in this thesis to be more impactful, and builds on an existing skill set (I have authored editorial articles for the Guardian, the Daily Mail, and the Times newspapers, the British Broadcasting Corporation (BBC), Geographical Magazine, and other publications). Early in my PhD studies, I sought opportunities to better understand the science behind knowledge exchange, and to gain practical experience of this.

Knowledge exchange has been described as “a two-way exchange between researchers and research users, to share ideas, research evidence, experiences and skills” (Economic and Social Research Council (ESRC), 2019). Building strong relationships and collaborations can be beneficial for all parties and is not limited to sharing research findings upon research completion but can be encouraged at any stage of the research process (Committee of the Health and Medical Research Strategic Review, 1999; London School of Economics and Political Science (LSEPS), 2019). Indeed Mitchell, Pirkis, Hall, & Haas (2009) articulate that “ongoing partnerships between researchers and decision-makers are critically important to effective transfer and exchange of knowledge generated from health services research”.

Effective partnership or as a minimum discussions between researchers and decision-makers, are often described as the most important factor or at least an important factor regarding whether or not research evidence is used by end-users (Lavis, 2006; Lomas, 1997a,b; Mitchell et al., 2009; Ross, Lavis, Rodriguez, Woodside & Denis, 2008). It should be noted that the varied timeframes within which stakeholders operate under can put pressure on collaborations and requires careful thought. When working in policy and industry, my experience is that timeframes to gather evidence to inform decisions were often hours to days, while months and even years are more optimal for research (Lavis, 2006). Wiseman, Carey, Langdovdt, & Barraket, (2015) neatly describe “parallel universes within which researchers and policy makers produce, analyse and communicate” evidence and ideas. Building stronger links helps to create and maintain a value chain in knowledge transfer, and opportunity to generate impact (Lomas, 1997b; ESRC, 2019). Each group can gain knowledge and ideas, but also understand the context and pressures that face other stakeholder groups.

Researchers can help build bridges towards end-users of their work by employing specific actions and tools to increase the visibility and uptake of research (Barton & Merolli, 2017; Ibrahim et al., 2017; Murray et al., 2018c, 2019a; Scott et al., Scott et al., 2016, 2017; Thoma et al, 2018). Traditional stages of producing research include i) assessing the need for research, ii) carrying out the research and iii) publishing the research. I built on these, and

the available evidence to systematically adopt further steps that included iv) creating digital resources (for example infographics, video, web content, v) sharing the resources using platforms such as conferences and social media and vi) evaluating the uptake, use and impact of our work. Underpinning this work is a recognition that building strong relationships and collaborations is vital at each stage in the process (LSEPS, 2019; Morton, 2015a).

As well as contributing to knowledge, I felt that the knowledge exchange activities I undertook were part of my personal growth and development. The more people that were exposed to the research, and the higher the level of engagement, the better the opportunity to collaborate further, gain feedback, and learn. As part of this, I aimed to keep the text within academic outputs as clear and concise as feasible (Sword, 2012), but also created and shared widely resources that could be digested by the range of stakeholders (for example the general public/ golfers, the golf industry, policy/ decision makers) as well as fellow researchers. In this chapter I describe the processes we adopted and adapted to produce a Research Impact (RI) tool.

5.1.3 Evaluating the uptake, use and impact of the research

Evaluation has been defined as “determining the extent to which a program has achieved its intended outcomes and the processes undertaken to achieve these outcomes” (Bauman & Nutbeam, 2013). The evaluation of research, facilitates policies and practices that are well-informed and supports future planning. Evaluation provides a better ability to predict the results if programs were extended/ rolled out (Government of Western Australia (GWA), 2013; Nutbeam, 1999) than if evaluation is not undertaken. Evaluation will vary considerably based on resources available, and other contextual factors. The risk of bias when evaluating your own research is obvious. Although Grant, Brutscher, Kirk, Butler & Wooding (2010), assessed various evaluation frameworks to measure impact, noting that evidence-based case studies, even when performed by the research teams being evaluated themselves are better than purely quantitative metrics and can produce valid results.

In public health and sports and exercise medicine, building on Bauman & Nutbeam’s (2013) work, evaluation may help researchers, research projects and programs to determine

- What impact did you have?
- Was it value for money?
- Did the project meet its goals?
- (why did it not meet its goals)
- How could we improve the project?
- What would be logical next steps for research?

Public health and sport and exercise medicine research is often practically applied and evaluation can be challenging. Attributing a change in health beliefs (for example amongst patients or practitioners), changes in behaviours or practice, or change in policy to a single or specific research outputs is frequently problematic (Morton, 2015a). Often the aim of public health research and intervention is to effect change across multiple stakeholders, perhaps even involving multiple sectors (Schut et al., 2014).

Recognising the systems (for example health and sport) within which the research is looking to contribute (Donovan, 2011), and the barriers and enablers of change within these systems (Williams, 2011), I felt that a framework that can assess a *contribution* to impact, rather than one attempting to demonstrate cause and effect relationships was required. I assessed various strategies/ frameworks to evaluate research and its impact on policy and practice (Campbell et al., 2000; Glasgow, Vogt, & Boles, 1999; Milstein & Wetterhall, 1999; Morton, 2015a; Schut et al., 2014; Searles et al., 2016; Van Eerd, 2011). Each of these provided different perspectives, and often sets of tools appropriate to the context of the authors. In addition to requiring a framework assessing a contribution to impact, I was looking for a framework that recognised that research users do not function only as passive recipients but can actively collaborate in the conduct of research.

The Research Contribution Framework (RCF) (Morton, 2015a, b) represented the best fit for my research for the reasons detailed below, and could be applied across a range of public health/ sports and exercise medicine research. It explicitly acknowledges the critical role of building relationships with stakeholders and addresses many of the main challenges of evaluating research in a complex world. It can provide a link not only between research inputs, but also other activities (for example efforts regarding knowledge translation) and uptake, use and impact. Evaluation can be re-visited, building on initial evaluation. Both qualitative and quantitative information can be integrated. Challenges include (as was the case for me) a research group more familiar with conducting research rather than evaluating research, and delineating what success would look like through the identification of outcome indicators.

Logic models/ pathway to impact models may also add value to researchers including public health/ sports and exercise medicine researchers looking to evaluate their work (Bauman & Nutbeam, 2013; Kellogg Foundation, 2004). They helped me map this project, building a step by step plan of what I wanted to achieve and helped measure if we were achieving these aims. They can help demonstrate a “chain of connections” (Bauman & Nutbeam, 2013) showing outcomes based on available evidence. We utilised pathway to impact

models/ logic models as tools to help planning our efforts to maximise impact, and then to evaluate impact. To do this I

- i) Identified persons who could contribute to our evaluation
- ii) Identified a guiding framework (the Research Contribution Framework)
- iii) Grouped outcomes regarding uptake, use and impact into common themes
- iv) Collated existing data, and collected new data
- v) Assessed outcomes and reflected these in the Pathway to Impact models shown in Figures 7, 12 and 14.

5.1.4 Published article and author contributions

This chapter describes my efforts to maximise uptake use and impact while developing and using the Research Impact (RI) tool, and evaluate the impact of the golf and health research utilising Morton's Research Contribution Framework.

A paper outlining this work was published in the British Journal of Sports Medicine (BJSM) namely

- Murray AD, Kelly P, Morton S, Glover D, Duncan J, Hawkes RA, Grant E, Mutrie N. (2019c). Maximising and evaluating the uptake, use and impact of golf and health studies. Br J Sports Med, online first, Dec 2019.

For this paper, I conceived the idea and developed the method with Paul Kelly, with input from Sarah Morton, and support from Christian Barton and Tessa Strain. I collected the data and developed a first draft. I designed graphical content with DG and JD. All authors commented on drafts and the final manuscript. As per previous chapters, word limits of the publishing journal do not permit as thorough discussion as is needed for the purpose of this thesis. Therefore, in addition to the published work, an introduction, discussion of the principal findings, strengths and limitations, context and summary are included in this chapter. In order to present the published study in full, while providing suitable background, some repetition has been needed.

5.2 Maximising and evaluating the uptake, use and impact of golf and health studies

“Maximising and evaluating the uptake, use and impact of golf and health studies” was published in the British Journal of Sports Medicine in December 2019.

Further supplementary files, published online only with the document are presented in the Appendix to this thesis, as below:

Appendix 17 Updated status of research priorities identified in 2016 Scoping Review.

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A link to the article and the full article are below.

Link to online article

<https://bjsm.bmj.com/content/early/2019/12/18/bjsports-2019-100994>

Full article



Maximising and evaluating the uptake, use and impact of golf and health studies

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► Additional material is published online only. To view, please visit the journal online (<http://dx.doi.org/10.1136/bjsports-2019-100994>).

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ABSTRACT

Introduction The dissemination of research, and evaluation of its impact is an increasing priority for the scientific community and funders. We take the topic of golf and health and aim to outline processes that may contribute to improved research uptake, use and impact proposing a research impact (RI) tool. We then evaluate our published research using the Research Contributions Framework (RCF).

Methods Building on existing research and frameworks we i) assessed the need for, ii) carried out and iii) published research, before iv) creating digital resources, v) sharing these resources widely and vi) evaluating our research.

To evaluate uptake, use and impact of our three principal golf and health research outputs, we performed a contributions analysis, using the RCF first proposed by Morton.

Results/Discussion We developed a specific six-step Research Impact tool. Having implemented this, research uptake and use included over 300 press articles, a dedicated website and social media channels. Golf's global industry leadership dispersed information across >150 countries, embedded golf and health into curricula for industry professionals and used leading tournaments to promote health. National policy makers hosted dedicated meetings regarding golf and health and began to implement policy change.

Conclusion To date, strong uptake and use can be demonstrated for these studies, while a final contribution to impact requires further time to determine. Frameworks we used aiming to maximise impact (Research Impact tool) and evaluate its contribution to uptake, use and impact (Research Contribution Framework) could potentially add value to public health/sports medicine researchers.

INTRODUCTION

The effective communication of research, demonstration of impact beyond academia and the building of relationships between researchers and key stakeholders are increasingly recognised as key in building dynamic and responsive research communities.^{1–5} Impact was first formally assessed in the higher education sector in the UK in the 2014 Research Evaluation Framework,¹ and in 2021 demonstrating impact will account for a higher percentage of the overall grade for the presenting institution/university. Public health/sports medicine can benefit from increasing efforts to maximise the uptake, use and impact of research, aiming to have research shared widely and facilitate action by participants, policy makers, industry bodies and

other research teams. Evaluation can assess what has worked, and what lessons can be learnt.

Research groups and journal publishers have suggested frameworks to maximise research visibility, its uptake and use.^{6,7} These highlight opportunities to break down barriers to research use, for example, article access, perceived lack of user time and lack of user engagement.⁶ Actions researchers can take to make research accessible to the end user are described^{6–10} including the creation of 'bite-sized' communication resources and planned use of social media. Also described is the opportunity to go beyond citation numbers, Altmetric and download numbers to evaluate research. The Research Contribution Framework (RCF)¹¹ originally published by Morton provides a practical approach used by academics/universities for *evaluating* the uptake, use and impact of research, helping to analyse how research can impact the real world. Morton¹¹ defined these terms as follows:

- **Research uptake:** research users have engaged with research: they know the research exists.
- **Research use:** research users act on research, discuss it, pass it on to others, adapt it to context, present findings, use it to inform policy, or practice developments.
- **Research impact (RI):** changes in awareness, knowledge and understanding, ideas, attitudes and perceptions and policy and practice as a result of research.

It is seldom possible to attribute broad health messaging and policy change to specific research papers, but the framework provides a tool to evaluate the potential *contribution* of research to uptake, use and impact.

Global Action on Physical Activity's 'best investments' guide¹² recognises the need for sports systems and programmes that promote participation across the life span. Golf is a sport played by over 60 million persons across the life span on six continents worldwide.^{13,14} The World Golf Foundation (WGF) recognised the opportunity to explore the relationships between golf and health aiming to increase interest and participation in the sport, and recognising economic, social and other barriers to participation. Our Golf and Health research team aimed to conduct strong scientific research that identified relationships between golf and health and share this information widely.

In this current paper, we take the topic of golf and health and aim to outline processes (Research Impact tool) that may contribute to improved research uptake, use and impact. We then evaluate the uptake, use and impact of our published



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research using the Research Contributions Framework (RCF). We also discuss how these approaches may be relevant to other public health/sports and exercise research.

METHODS

Overview

We aimed to generate research with high uptake, use and impact by building on existing evidence/frameworks⁵⁻⁷ to refine a six-step process, creating and using a Research Impact (RI) tool.

Following this, we used the RCF to evaluate the impact of our golf and health research.

Maximising uptake, use and impact, and developing the Research Impact tool

We engaged directly with stakeholders including golfers, the golf industry, policy makers and fellow scientists. This building of relationships, involvement of stakeholders and recognition of cultural and contextual considerations underpin efforts to achieve impact^{2-4 11} and we consulted these groups at each step of the process outlined below.

Step 1. Assessing the need for research and consider intended use and impact

Working out what research is needed and can practically and feasibly be conducted offering a good return for time, monetary and other resource deployment is a key first step in creating impactful research. We directly discussed research opportunities, and the intended use and impact of research with key groups including researchers, policy makers and the golf industry.

Step 2. Carrying out the research

A research team was selected which included academic researchers and those with a practice and policy background, providing understanding of the context for the research. Researchers with specialist methodological knowledge were consulted as appropriate and bimonthly meetings appraised progress and determined future steps and research priorities.

Step 3. Publishing the research in academic journals and making it accessible

Publishing in peer-reviewed journals is important to gain feedback during review, and for credibility. Our method was to identify factors that facilitate access to end-users. Once we had identified these factors, we aimed to publish in reputable, peer-reviewed, high impact and engaging journals that could support access for end-users and maximise potential uptake.

Step 4. Creating communication resources

Research impact can be positively influenced through multifaceted opportunities to engage with findings.^{15 16} We reviewed the literature regarding communication resources, and spoke with authors of key papers, and with journal editors and professional journalists to establish a strategy.

Step 5. Sharing the research and associated resources

Social media platforms including Twitter, Facebook, Instagram, YouTube, websites and others can take content and share beyond traditional research users.^{6-8 10} We met with professional golfers, golf industry leaders, policy makers and scientific colleagues in advance of each publication to establish systems and processes to share our research and associated resources widely.



Figure 1 Research impact tool. Processes to support high uptake, use and impact of research.

Step 6. Evaluating the uptake, use and impact of the research and the Research Contribution Framework

At the start of the research programme, we committed to evaluate the contribution to knowledge and impact of our work on golf and health. Members of the research team teach public health evaluation courses, and evaluation was discussed with faculty, with experts from organisations such as Institute for Health Improvement, World Health Organisation (WHO) and with independent consultants. We determined that a ‘contributions approach’ was appropriate in linking research to activity and outcomes, being practical and balancing feasibility and rigour.¹¹

Thus, we used the Research Contribution Framework and existing literature^{4 5 11 16 17} to capture uptake, use and impact for each key research study, involving the author of the RCF with our work. Data regarding the uptake, use and impact of each research paper was collected by the first author (AM). Citations, downloads, Altmetric and number of press articles were checked and then updated 30 June 2019. Coauthors were asked to share examples of uptake, use and impact with the first author. Following analysis of the data, we produced models demonstrating the pathway to impact for each research study and a narrative synthesis providing additional detail.

RESULTS AND DISCUSSION

The Research Impact tool detailing processes to support high uptake, use and impact of research is shown in figure 1.

We provide results and discussion from using the tool with our golf and health research below.

Step 1. Assessing the need for research and considering intended use and impact

WHO and public health leaders have called for individual sports to help identify what is known about the associations between their sport and health, and to show leadership in promoting physical activity for health and collaborative action.^{12 18} We alerted the WGF to this opportunity. The WGF unites and represents the key players in the global golf industry, and determined action was required, agreeing to i) establish an advisory board on golf and health, ii) fund research to evaluate the health benefits and disbenefits of golf.

Step 2. Carrying out the research

An important stage was to comprehensively review what was known about the relationships between golf and health. The Scoping Review¹⁹ mapped the available evidence finding associated improved physical health and mental well-being, and a potential contribution to increased life expectancy. It highlighted the existing knowledge gaps including golf's contribution to muscular strengthening and balance, and the associations/effects between golf and mental health.

Second, to evaluate a knowledge gap we conducted the first study of golf spectators step counts, and their reason for attendance.²⁰ Step count was used, as physical activity while spectating is primarily walking. Over 10 million spectators²¹ attend professional golf events worldwide each year. In our study, spectators took a mean of 11 589 steps providing an initial step in evaluating whether health enhancing physical activity can be achieved while spectating, and what may facilitate this.²⁰

Third, clarity was required on the suggested actions that i) golfers/potential participants, ii) the golf industry/facilities and iii) policy/decision makers external to golf can take to positively influence health through golf and avoid any negative health consequences associated with the sport. We used modified Delphi methodology engaging 25 expert panellists including experts in public health, policy and golf to produce an international consensus on golf and health²² highlighting concrete actions to promote better health through golf and increase inclusivity and diversity.

Step 3. Publishing the research in academic journals and making it accessible

Publishing research open-access can positively influence the uptake of research. Evidence suggests that downloads, altmetrics and citation rates are higher for open-access publications compared with articles subject to a pay-wall.¹⁵ Our end-users extend beyond academia. Publishing articles on golf and health without open access would decrease the opportunity for members of the public, golfers, the golf industry and policy makers to review the full scientific article and judge the science for themselves.

Higher impact journals produce on average more downloads and citations. Many leading journals encourage the creation of digital/communication resources to support publication, while some have websites, platforms and social medias that can support dissemination.

The scoping review,¹⁹ spectator health study,²⁰ international consensus on golf and health²² and associated studies^{23–29} were all published open access following peer-review, with six publications in the *British Journal of Sports Medicine*, which has the strongest 2019 impact factor (11.6) in the field, whose website achieves >8 million hits per year, and has >200 000 followers of their social medias.

Step 4. Creating communication resources

Our literature review supported that creating bite-sized communication resources from the content of published studies can deliver more engagement.^{6–9 30} The UK Chief Medical Officers have used infographics to distill key messages on physical inactivity.³¹ Communication/digital resources are not a substitute for reading the full research article or guideline, but can provide an accessible summary, and encourage the user to access the full article.³⁰ Communication resources can include infographics/visual abstracts, video, podcast, blogs and press release.^{6–10 30 31}

For each principal publication, we engaged with potential end-users before producing as a minimum, infographics, which were published postpeer review,^{23–25} podcast and video material.

Step 5. Sharing the research, associated resources and relevant information

We encouraged leading figures in golf to take an interest and leverage their networks. This included golf and health player ambassadors with >25 major championship titles between them, female and male, representing five continents and an age range of 20–82 years. The ambassadors agreed to promote the findings from each of the three research products and other key public health/physical activity messaging via their social media, the conventional media and through their networks.

In addition, we produced summaries for policy makers and industry leaders, and sought meetings with them. We targeted major, relevant scientific conferences to present our work.

Step 6. Evaluating the uptake, use and impact of the research using the Research Contribution Framework

Figures 2–4 show the pathway to uptake, use and impact of:

- (i) The golf and health scoping review¹⁹;
- (ii) The golf spectator study²⁰;
- (iii) The international consensus on golf and health²² using the RCF,¹¹ with further description in the accompanying text.

Golf and health scoping review

The scoping review¹⁹ achieved strong uptake and use with >120 popular press outputs, and direct use by golf industry leaders and parliamentary groups. This research has become embedded in curriculums for teaching professionals. Academically, it has become a primary reference point in the field, having >33 000 full text or PDF accesses, 19 citations and being in the top 1% of all papers by Altmetric. It has helped shape the research agenda, identifying research gaps and in some instances directly helping to secure funding to address these.

Cross-sectional spectator health study

A concrete use of this research²⁰ has been to develop public health initiatives at events which include the Ryder Cup, the Open Championship, the Women's British Open, the Solheim Cup, the Andalucia Masters and events in China and Indonesia. These have been attended by >1 million spectators, and have engaged leading professionals to advocate for increasing physical activity, and involved collaborations with local authorities and in many cases government departments. To date, >70 popular press articles have appeared, with 7 academic citations. The primary paper has had >2000 full text/PDF downloads, and is in the top 5% of all papers by Altmetric. Our further work²⁶ showed that 40% of spectators self-reported increasing physical activity postintervention at a Scottish event, although further study to optimise interventions, and assess generalisability is needed.

International Consensus on Golf and Health

The International Consensus on Golf and Health²³ has generated four citations to date and provided concrete guidance for golfers, the golf industry and facilities and for decision makers to improve health through golf. It demonstrated strong uptake and use in the months since publication, with >9000 full text/PDF downloads, an Altmetric in the top 1% of all papers and

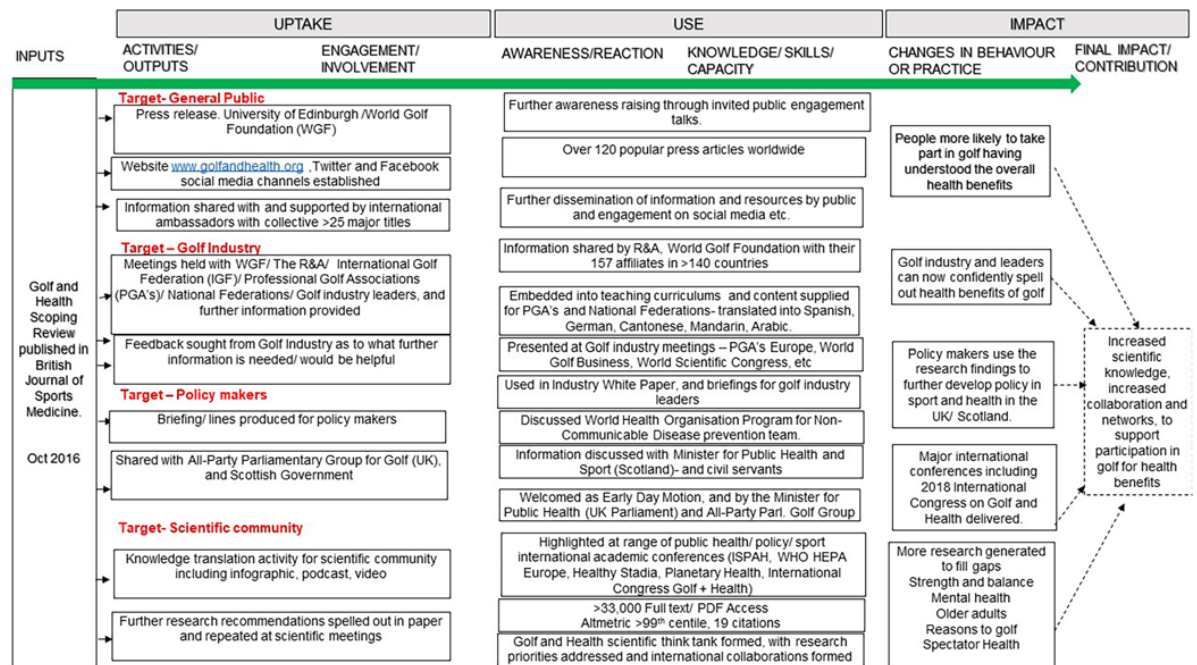


Figure 2 Pathway to impact of 'golf and health—a scoping review'.

>120 media articles. It has been discussed with nine government ministers or heads of state, and senior leaders from all seven organisations represented on the board of the WGF. Its contribution to impact will be better determined in the years to come, although some early examples are evident. Tony

Bennett, Head of Inclusion and Disability at the International Golf Federation describes that:

The International Consensus on Golf and Health, and other research led by the University of Edinburgh and the World

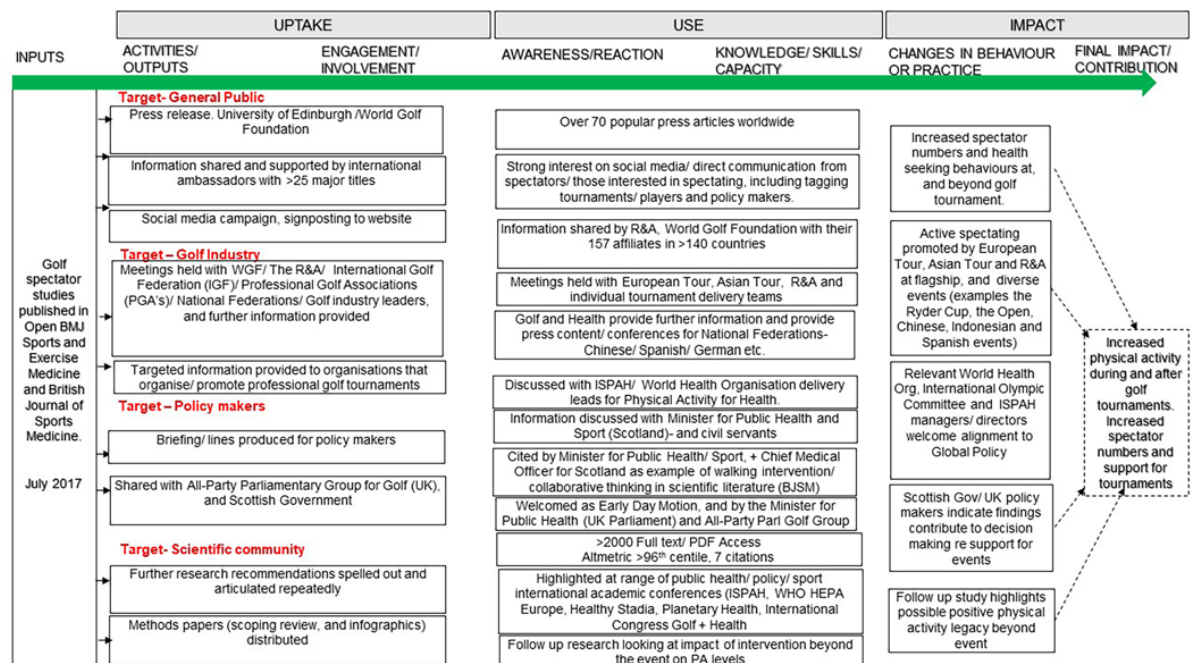


Figure 3 Pathway to impact of 'Golf Spectator Physical Activity' study.

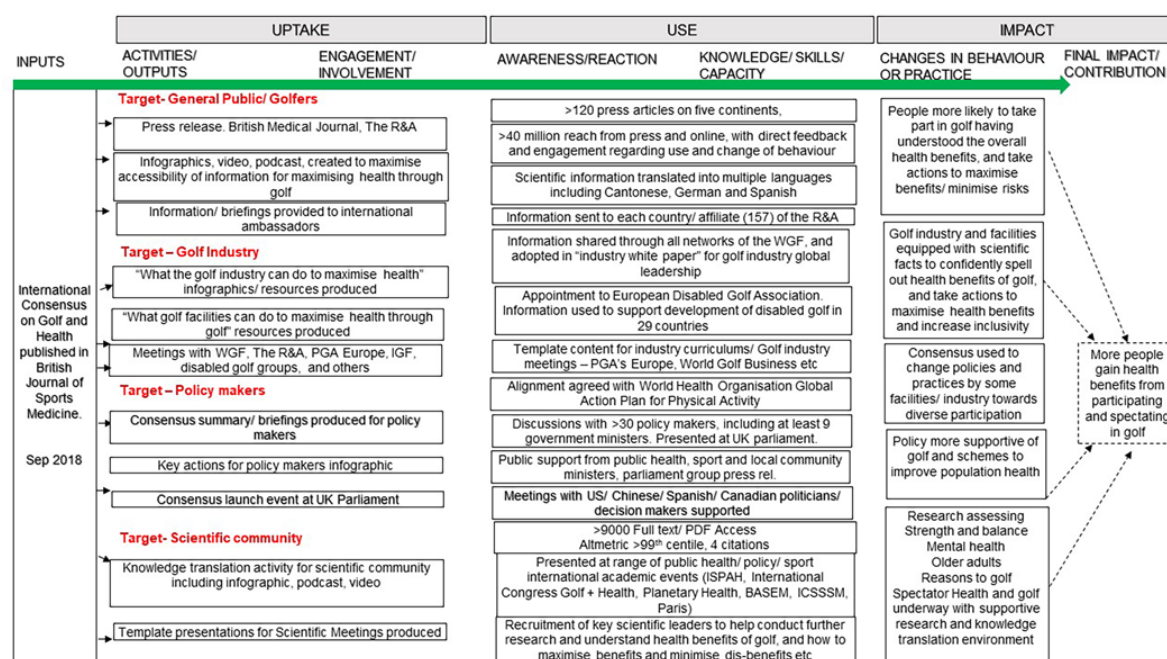


Figure 4 Pathway to impact. 'An International Consensus on Golf and Health'. HEPA, Health Enhancing Physical Activity; ISPAH, International Society for Physical Activity for Health.

Golf Foundation has helped considerably in bringing policy makers, and the golf industry together towards increasing inclusivity around golf. Examples include collaborations relating to development initiatives and tournaments for golfers with a disability through EDGA (formally the European Disabled Golf Association), communications regarding health benefits of golf for all of society, and detailed discussions with government ministers.

Summary by stakeholder group

Uptake, use and impact for general public/golfers

Activities including building relationships with key stakeholders, developing press releases and websites, social media engagement and the involvement of golf and health ambassadors supported the uptake and use of the research inputs. Overall, over 300 broadcast television, radio, print/online articles have highlighted research findings including major networks like CNN, NBC, BBC, Sky Broadcasting and the front pages of several newspapers. The research has been translated into several languages including Spanish, German, French, Mandarin and Arabic.

Some feedback has been received regarding changes of behaviour, for example, 65.1% of 129 respondents reported considering increasing physical activity, and 40.4% self-reported increased physical activity levels 3 months postreceiving information at the Paul Lawrie Matchplay where they were spectating.²⁶ Receiving messaging from persons or organisations favoured by the end-user can positively influence behaviour.³² Engaging athlete ambassadors representing five continents, and a wide range of ages may facilitate changes of behaviour. Examples of public facing information are shown at www.golfandhealth.org.

An intended impact of a contribution to increased overall global participation and interest in the game cannot be shown at this stage, but many promising regional examples such as China highlights golf and health messaging in increasing participation

evidenced in the quote below from the 2018 International Congress on Golf and Health:

Golf and health is the most important area for China Golf currently. We are seeing growth and aim for more than 500% increase in junior participation between 2018–2022.

Mr Wei, Director of Golf Development. China Golf Association.

Uptake, use and impact for the golf industry and facilities

Key messages and actions from our research were included in the 2016, 2017 and 2018 Industry White Papers, which shares key information and actions for Golf's global leadership. WGF Chief Executive Steve Mona reports 'the golf industry is now equipped with stronger science on golf and health and can take concrete actions to improve health for people'.

Examples of use include the R&A sending information to each of 150 affiliated National Federations and suggesting adoption of health promoting actions. The Professional Golf Associations of Europe/Confederation of Professional Golf have facilitated the adoption of golf and health into the curriculums for all prospective coaches in their area of influence.

Changes in behaviour/practice include the promotion of physical activity for health, and active spectating at some of the biggest golf events worldwide, as previously described. Industry leaders have highlighted they view this positive health messaging as an opportunity for i) further revenue, ii) strengthening commercial and governmental partnerships as well as iii) potentially improving health. Feedback confirms adoption of messaging and recommendations by some facilities, with the Golf Club Managers Association of the UK, being signatory to the action plans suggested for facilities in the consensus document. The Home of Golf (St Andrew's Links Trust) are taking

action to diversify facilities and encourage industry partners to support the golf and health initiative.

The golf and health research has likely contributed to the further prioritisation of increasing inclusivity and diversity within the sport. Examples of leadership include the R&A's Women and Girl's Charter, a worldwide initiative. A member of the research team (RH) has been appointed to the EDGA to further support development of inclusive policies and actions. At the Australian Open and Scottish Open, players with a disability were integrated into the professional event showcasing leading players and working with local government to promote inclusivity in golf and sport more widely.

Uptake, use and impact for policy makers

Activities to support uptake and use by policy makers included providing summary briefings, and infographics spelling out the relationships of golf with health, and actions to support improved health through golf, physical activity more generally and opportunities to align work to local, national and international policy.

This supported awareness and capacity for use. Speaking at the launch of our international consensus on golf and health, WHO Director of Non-Communicable disease Professor Fiona Bull describes golf's efforts to contribution to health improvements:

Golf is a popular sport for men and women and it is great to see golf's global leadership recognising health priorities and identifying ways golf can be more accessible to more people.

Better awareness of golf's health benefits, and opportunities to support golf and physical activity through policy has been observed. Direct communications indicate this has informed and help shape policy regarding major events, health and social prescribing, and walking/physical activity policy. In the editorial 'Physical activity investments that work—A National Walking Strategy for Scotland' co-written between our research group,

the Minister for Public Health and Sport and the Chief Medical Officer for Scotland, actions taken are outlined as follows: "we work with the World Golf Foundation, the R&A and the European Tour to encourage spectators to walk the course. Our golfers are encouraged to walk the course rather than riding carts".³³ Multiple motions in the UK Parliament have welcomed the research and opportunities related to golf and health, while the All-Party Parliamentary Group on Golf are signatory to the International Consensus on Golf and Health and the suggested actions for policy makers.³⁴ Figure 5 highlights the interlinking activities of our research, policy makers and the golf industry.

Uptake, use and impact for the scientific community

The golf and health research team included professors in global public health and physical activity for health.

Studies were presented at many local, national and international meetings including the World Scientific Congress on Golf, the World Golf Business Forum, the International Congress on Golf and Health, Planetary Health, the International Sports Science and Sports Medicine Conference and WHO-sponsored events including International Society for Physical Activity for Health and Health Enhancing Physical Activity Europe meetings.

Recommendations for further research were articulated in the 2016 Scoping Review,¹⁹ and repeatedly spelled out during scientific meetings and forums. An update of the status of these research priorities is shown in online supplementary appendix 1. In summary, these have substantially moved forward, with funding decisions and prioritisation for golf and strength and balance and spectator health directly influenced by the scoping review and other research agendas being taken forward collaboratively.^{35–42}

Interdisciplinary and international collaborations have been facilitated by events including the International Congress on Golf



Figure 5 Examples of uptake and use. (A) UK Parliament motion on golf and health. (B) Ambassador Gary Player (South Africa) welcomes the launch of International Consensus on Golf and Health¹⁹ at parliament. (C) Andrew Murray (University of Edinburgh), Fiona Bull (WHO), Steve Brine (UK Government), Annika Sorenstam (player ambassador), Martin Slumbers (the R&A), Craig Tracey (Parliament Golf (APPG)) pictured in tweet by Steve Brine (Minister for Public Health). (D) Example of spectator health initiative supported by players, golf industry and Scottish Government.



Figure 6 Infographic. Processes to support high uptake, use and impact of research.

and Health. For example, groups in Australia, Japan and the UK are evaluating interventions relating to golf and dementia, while the associations between golf, strength and balance are being investigated collaboratively by the University of Southern California and University of Southampton.

Strengths and limitations

It was agreed that findings would be published for each of the studies regardless of the results. Clearly, involving and accepting funding from the golf industry presents a conflict of interest/potential limitation when stakeholders have interests (eg, financial/commercial) in supporting some, but not all of the research findings. Nevertheless, industry has largely supported efforts to counter inclusivity and diversity issues identified in the consensus, and tackle health disbenefits identified (eg, with skin cancer awareness, and efforts to set up prospective epidemiological injury studies). It is likely that conflict of interest through industry involvement will be a consideration in other sports/public health studies, which can be a limitation (risk of bias) but can be very valuable for practical implementation.

The Research Impact tool offers value in offering transferable and practical steps that may contribute to increased uptake, use and impact. While it builds on the available evidence we expect with time and as evidence emerges it can be further improved. We emphasise the importance of engaging key stakeholders and noting the considerations for particular aspects of public health/sport. Additionally, technology evolves quickly, so while infographic, animation, podcast and blog are useful communication resources currently, and Twitter, Instagram, Facebook, etc are prominent platforms to share this content, type of communication tool and platform will change and we encourage researchers to use what is most relevant to their end-user group.

The choice of a Research Contribution Framework reflects an implicit acknowledgement that causal attribution in a complex world is a limited notion, and that appraising a plausible contribution to impact is the goal. Many research articles and other factors can contribute to an eventual outcome. We acknowledge

it is infrequently possible to directly attribute wide public health messaging or policy change to specific research output, and we highlight likely contributions to change rather than causative effects.

Research impact, defined by Morton as ‘changes in awareness, knowledge and understanding, ideas, attitudes and perceptions, and policy and practice as a result of research’¹¹ can take many years before being fully evident. Our evaluation was limited in that the research was published between 6 and 27 months before the evaluation, before eventual impact can be determined. Despite this funders and other stakeholders welcomed the process of evaluation, using a contribution analysis, and we recommend it is considered for programmes of research in public health, sport and the social sciences.

Key learning and practical application

Building strong relationships and taking into account the opinions/expertise of key stakeholders (in our case with fellow researchers, the golf industry and facilities and public health stakeholders) is vital at every step in maximising uptake, use and potential impact. Our Research Impact RI tool is displayed as an infographic in figure 6, and in video form at this link (<https://www.youtube.com/watch?v=aNtIK6LC8Lc>). The RI tool may provide guidance to help public health/sports researchers maximise the impact of their work, potentially increasing visibility, engagement and supporting action based on the research produced.

Having a commitment to evaluation helped understand what worked, and what did not. The RCF was practical and can be applied to a range of settings. The RCF lends itself well to public health and sport research providing insights into the potential contribution of research to changes in practice/policy. It can link research to outcomes and impact, appreciating that social science impact evaluation is complex.

What is already known?

- Evaluation of the impact from research is gaining priority with the scientific community and funders but this can be challenging.

What this paper adds and how might it impact future practice?

- We outline specific processes that may contribute to improved research uptake, use and impact (research impact tool), which may be transferable to other public health/sports medicine research.
- The Research Contribution Framework can support evaluation of the uptake, use and impact of research and may add value to public health/sports medicine researchers.
- We demonstrate uptake and use among key stakeholders regarding golf and health, including participants, industry leaders, politicians/decision makers and the scientific community.
- Our golf and health research contributed to >300 popular press articles, increased awareness/action regarding inclusivity from golf industry, action from government ministers and the commissioning of further research to target identified knowledge gaps.

CONCLUSION

We outline a Research Impact tool, highlighting specific, transferable processes that may contribute to the uptake, use and potentially impact of research. This is intended as a guide, rather than a set of infallible rules. We found it helpful in maximising the uptake, use and impact of our golf and health research, which highlighted that golf can provide health enhancing physical activity, and a range of actions that can be taken to promote better health through golf.

We then evaluated our work by contributions analysis, using the Research Contribution Framework first described by Morton. The golf and health research described has had strong uptake and use with the general public, golfers, golf industry and facilities and policy makers recognising we describe contributions as opposed to direct causal effects. Further time and evaluation is needed to determine its contribution to an intended impact of a better understanding of golf and health and increased interest and participation in physical activity and in particular golf.

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Contributors AM conceived the idea and developed the methodology with PK and those acknowledged. AM designed graphical content with DG and JD. SM provided guidance on the Research Contribution Framework. All authors worked together to produce a draft and final manuscript.

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5.3 Principal findings

Efforts to maximise and evaluate impact from research are gaining priority with the scientific community, educational institutions and funders but this can be challenging. In the above paper, I outlined a Research Impact (RI) tool, with transferrable processes relevant to Public Health/ Sports and Exercise Medicine research that may contribute to improved research uptake, use and impact. The Research Contribution Framework (RCF) I utilised can support evaluation of the impact of Public Health/ Sports and Exercise Medicine focused research. I demonstrated uptake and use amongst key stakeholders regarding golf and health, including participants, industry leaders, politicians/ decision makers and the scientific community.

5.4 Further discussion and context

5.4.1 Maximising and evaluating impact gaining priority with the scientific community,

The published paper and introduction to this chapter describe a clear direction of travel in which efforts to maximise the impact of research are becoming a requirement, rather than an option for researchers and educational institutions if they are to be successful (Best & Holmes, 2010; Higher Education Funding Council for England, 2014, 2017; Ozanne et al., 2017; The UK Economic & Social Research Council, 2015). In addition, evaluating impact can help researchers, institutions and funding bodies assess whether aims and impact have been achieved, which may influence future resource allocation. I purposefully investigated the literature regarding what we could practically do to maximise impact and evaluate our work.

5.4.2 The Research Impact (RI) tool

When I enrolled as a PhD student, a clear aim was to learn about research methods, and use this to contribute new knowledge in my chosen topic area. I also reflected on previous research I had published, and considered what I had done well, and what lessons could improve the impact of my work.

Several conversations with Christian Barton, who went on to publish “it is time to replace publish or perish with get visible or vanish: opportunities where digital and social media can reshape knowledge translation” (Barton & Merolli, 2017) helped me recognise that I had focused only on conducting/ writing the research, and getting it published. I had made at best token efforts to increase the visibility of the research through creating engaging further content and sharing it widely- key further steps described in Barton and Merolli’s model. I was falling into this trap across multiple topic areas. Examples of these include papers on i) physical activity for health (Burns & Murray, 2014; Dunlop & Murray, 2013; Murray, Calderwood, O’Connor & Mutrie, 2016), ii) sport, and interventions to decrease injury risk (Murray, Murray & Robson, 2014, 2015) and iii) injury epidemiology in sport (Scheer & Murray, 2011) where we had achieved publication, but very little uptake and use despite the constructs being sound.

I looked in depth at knowledge translation tools, helping co-author papers looking at why health professionals should know about infographics and digital tools (Murray et al., 2017d; Scott et al., 2016), and how to create engaging infographic and video content building on the available evidence (Murray et al., 2019a; Scott et al., 2017). I further researched and

described how content once created can be shared widely across digital platforms to increase visibility and uptake (Mackenzie, Murray & Oliver, 2018; Murray et al., 2019a).

While assessing how to maximise visibility and impact of research, I began to build on Barton and Merolli's model. Principally I felt that the further additions this model would benefit from were:

- i) A recognition that building relationships, and working with key stakeholders at each stage of the process adds considerable value (Morton, 2015a,b; Oliver, Innvar, Lorenc, Woodman, & Thomas, 2014; Ozanne et al., 2017)
- ii) Careful thought, in assessing what research is needed, and offers value for resource deployment – often in collaboration with practitioners, and policy makers is necessary.
- iii) Committing to, and carrying out evaluation (Morton, 2015a; Schut et al., 2016) would help assess impact, return on time and other resource investment, and permit reflection and further improvement.

For the first of these, I found it vital to benefit from being embedded in stakeholder groups, but also to be able to create space scientifically to critically evaluate what these stakeholders say, and what their vested interests are. These relationships can add value to researchers looking to create impact (Morton, 2015a,b; Oliver, Innvar, Lorenc, Woodman, & Thomas, 2014; Ozanne et al., 2017), and is equally applicable to those not already working with sports federations and government, although in this instance relationships may take longer to foster. The published paper in this chapter outlines a Research Impact (RI) tool, based on the evidence and our practical experience which we hope other public health/ sports and exercise medicine researchers may find helpful, and can further improve.

The actions in the RI tool could be accomplished by one person or team of people, or alternatively different people, or persons could take responsibility for each stage. To follow a sporting analogy suggested by Dr Paul Kelly, this process could be conceptualised in two ways. First, like a golfer, who is responsible for each and every step (like taking the tee shot, the approach shot, shots around the green, and the putts), with inputs from coaches and caddies at various points as required. Or second, like a football team where each person or unit is responsible for a particular function (goalkeeping, defending, creating scoring opportunities, scoring goals) with some assistance from colleagues. For this project we followed the golf model, planning and executing each stage, but calling in expertise at each stage much in the same way golfers may get expert insight from a long game coach, putting

coach, strength and conditioning coach, statistician/ analyst, physiotherapist, doctor, nutritionist, sports psychologist or research scientist!

5.4.3 Opportunities in evaluation for Public Health/ Sports and Exercise Medicine and application of the Research Contribution Framework.

Evaluation can help researchers to gain insight into whether aims and objectives have been achieved, and enable stakeholders to reflect on insights gained, the value or worth of projects, and influence future decision making. In short, evaluation can assess what has worked, and what lessons can be learned (Bauman & Nutbeam, 2013; Kelly, 2018).

Researchers in public health and sports and exercise medicine have conducted research to evaluate the success of programs in public health (Huhman et al., 2007; Tudor-Locke et al., 2004), injury prevention (Barengo et al., 2014; Thorburg et al., 2017), and screening (Corrado et al., 2006; Dallinga, Benjaminse, & Lemmink, 2012). These often discuss the potential impact of an intervention, potential further improvements, and logical next steps for the program and for research. However there appears to be a dearth of studies in sport and exercise medicine that formally assess the uptake, use and impact of the research itself.

A range of evaluation frameworks can be used (Campbell et al., 2000; Glasgow, Vogt, & Boles, 1999; Milstein & Wetterhall, 1999; Morton, 2015a; Schut et al., 2014; Searles et al., 2016). While there are clear benefits in understanding whether research aims have been achieved, and in understanding the uptake, use and impact of research (Morton, 2015a) public health and sport and exercise medicine research is often practically applied and evaluation can be challenging. Attributing changes in behaviours or practice, or change in policy, to specific research outputs is rarely supportable. The Research Contribution Framework can evaluate a **contribution** to impact and highlight uptake and use and may add value for public health/ sports and exercise medicine research teams. Logic models/ pathway to impact models can assist in planning/ mapping a project, and showing outcomes based on the available evidence (Bauman & Nutbeam, 2013; Kelly, 2018). Health improvement can take time, often being preceded by changes in knowledge and attitudes in the short term, changes in behaviours in the medium term, with end points demonstrating improved health following this.

5.4.4 Uptake and use of our research amongst key stakeholders

The published paper in this chapter concludes

“the Golf and Health research described has had strong uptake and use with the general public, golfers, golf industry and facilities and policy makers recognising we describe contributions as opposed to direct causal effects. Further time and evaluation is needed to determine its contribution to an intended impact of a better understanding of golf and health and increased interest and participation in physical activity and in particular golf.”

The detail of the pathway to impact for our principal publications, and by stakeholder group are described in the published paper and not repeated here, but additional detail is provided in the Appendix section of this thesis as below

Appendix 18. Uptake, use and impact. Scoping Review. Social media and press activity captured by publishing journal.

Appendix 19. Uptake, use and impact. Scoping Review. UK Parliament Early Day Motion.

Appendix 20. Uptake, use and impact. Spectator Health. Press release and examples of press activity.

Appendix 21. Uptake, use and impact. Spectator Health. UK Parliamentary support and Early Day Motion.

Appendix 22. Uptake, use and impact. Spectator Health. Examples of implementation as a case study by The R&A shared with it's national federations.

Appendix 23. Uptake, use and impact. Consensus. Report of press activity by Dr Jonathon Greenspan.

Appendix 24. Uptake, use and impact. Consensus statement. Examples of press coverage.

Appendix 25. Uptake, use and impact. Consensus statement. Examples of social media interaction.

5.5 Strengths and limitations

Strengths and limitations of the Research Impact tool, the Research Contribution Framework, and our efforts to evaluate the uptake, use and impact are described in the published paper.

To summarise, our collaborations with the golf industry and with policy makers present a risk of bias but were highly valuable to gain insights and with practical implementation. We have achieved collaboration with each of our stakeholder groups namely

- i) Golfers and the general public
- ii) The golf industry and facilities
- iii) Policy makers/ decision makers
- iv) The scientific community

It is likely that researchers looking to maximise the impact of their work, and evaluate their research in other areas of public health/ sport may have some similar, but also some different opportunities and challenges. This may limit external validity. I do not present the RI tool as a set of infallible rules, rather as guidance to support efforts to maximise uptake, use and impact. Further work, in different contexts is required to establish the extent to which the tools, frameworks and our findings can be generalised to other contexts.

Grant, Brutscher, Kirk, Butler & Wooding (2010), assessed various evaluation frameworks to measure impact, noting that evidence-based case studies, even when performed by the research teams being evaluated themselves are better than quantitative metrics. However the risk of bias when evaluating your own research is obvious, and producing case-study reports evaluating the uptake, impact and use of research is resource intensive, and not likely to be feasible for every piece of research (Banzi, Moja, Pistotti, Facchini, & Liberati, 2011).

5.6 Chapter summary and conclusions

Research objectives to i) conduct a review of the literature ii) conduct original research to address identified knowledge gaps iii) provide guidance on what is known regarding golf and health, and what can be done to promote better health through golf had been achieved in chapters 2-4. In this chapter I have described efforts to evaluate the science and build on this to maximise, and evaluate the uptake, use and impact of research. I outline a Research Impact (RI) tool, with key, transferrable processes relevant to Public Health/ Sports and Exercise Medicine research that may contribute to improved research uptake, use and impact and discuss how the Research Contribution Framework (RCF) can support evaluation of the impact of Public Health/ Sports and Exercise Medicine focused research. Lastly, I demonstrate uptake and use of our work amongst key stakeholders, including participants, industry leaders, politicians/ decision makers and the scientific community.

Chapter six- Summary and conclusions

6.1 Summary of thesis

6.1.1 Background, vision and objectives of thesis

Chapter six summarises the main findings of the thesis, in relation to the stated vision and objectives. A discussion regarding stakeholder engagement, and personal reflections follows. Future priorities for research and implementation of findings are articulated, and overall conclusions drawn.

The **vision** for this thesis was to contribute knowledge regarding what is known about golf and health, and what can be advised to maximise health benefits, and minimise the health dis-benefits of golf. This vision, and the objectives below were specified in chapter one, figure 2.

6.1.2 Discussion of key findings and contribution to knowledge

The first chapter summarises the established longevity, physical and mental health benefits of regular physical activity (Department of Health and Social Care, 2019; Donaldson, 2004; Lee et al., 2012; World Health Organisation, 2019) and provides background information on golf. Following this introductory chapter, this thesis identifies the gaps in the literature on the associations between golf and health.

Chapters 2-5 met the specified objectives for the thesis. The second chapter of this thesis presents a scoping review (Murray et al., 2017a,b) assessing the relationships between golf and health. 301 studies met inclusion criteria for the scoping review. Golf can provide moderate intensity physical activity (Ainsworth et al., 2011; Luscombe et al., 2017) and is associated with health benefits that include improved cardiovascular, respiratory and metabolic profiles (Brown et al., 2016; Murase et al., 1989; Palank & Hargreaves, 1990; Parkkari et al., 2001), and improved wellness (Beard, 2007; Kim, Compton & Robb, 2011). There is limited evidence related to mental health, while robust studies assessing golf's association with longevity are required. No measures of physical activity obtained by golf spectators had been reported. More evidence is required regarding golf's contribution to persons meeting muscle strengthening and balance improvement recommendations.

The third chapter of the thesis addresses an evidence gap identified by the systematically conducted scoping review. Spectators at professional golf tournaments worldwide could gain health-enhancing physical activity (HEPA) during their time at the event (Murray et al.,

2017c). An initial cross-sectional study of spectators highlighted that obtaining exercise/physical activity (PA) can be a motivator to attend, and that spectators can engage in health-enhancing PA while at the event (Murray et al., 2017c). A follow up study of 135 spectators who responded to a questionnaire three months post intervention showed that 65.1% of spectators may contemplate/prepare to increase PA in daily life while 40.4% self-report an increase in PA during the 3 months post intervention at a golf tournament (Murray et al., 2019b). Spectators' preferred method for receiving information about 'active spectating' is via a big screen. These findings are presented with caution, as respondents may not be representative of all golf spectators.

The Scoping Review highlighted what is known, and what further work is needed. I was frequently asked, what actions were required. Golfers would ask "what can I do to get the most health benefits from golf?", while golf industry leaders and policy makers asked "what does it mean for us?". We had success with the spectator health studies in outlining concrete actions, that taken collaboratively led to these events working with local and national policy/ decision makers to put on health promoting initiatives. A consensus statement on golf and health utilising Delphi methods was agreed to be the next logical step, engaging leaders at the intersection of health, sport, policy and golf to build a cross-sectoral consensus statement relating to golf and health. Consensus findings, and their implications for players, the golf industry and facilities and policy makers are described (Murray et al., 2018a,b).

The fifth chapter describes strategies to maximise uptake, use and impact of the research and evaluates whether I achieved my aim to maximise uptake, use and impact with stakeholder groups that included i) golfers and potential golfers, ii) the golf industry and facilities, iii) the scientific community and iv) policy/ decision makers.

I used the available evidence to build and use a Research Impact tool (Murray et al., 2019c). The RIT takes research beyond the traditional first three steps to include publication, adding three further proactive steps to generate impact. A key principle of this tool was to build relationships and collaborations throughout the process. Stages comprise

- a) Assessing the need for research
- b) Carrying out the research
- c) Publishing the research, aiming for engaging and impactful journals
- d) Creating digital resources, for example infographics, podcast, web content
- e) Sharing the research and digital resources widely, for example across social medias
- f) Evaluating the uptake, use and impact of the research.

In addition to establishing the connection between golf and health, I have critiqued the ways in which research can generate uptake, use and impact, and modelled this in the RI tool. To demonstrate potential effectiveness, I then evaluated the uptake, use and impact of my studies using the Research Contribution Framework (Morton, 2015a, b) to explore and explain the uptake, use and impact of previous chapters from this thesis. There is clear evidence that the work contained in this thesis has had wide uptake and use. Its science and supporting information has been widely shared in >300 popular press and online articles, disseminated amongst golfers and potential golfers in >140 countries, has contributed to a greater understanding of the associations between golf and health in the golf industry, and has been discussed at local, national and international policy level. Examples include major golf events frequently encouraging spectators to walk the course, a collaboration between government, event organisers and our academic team. The China Golf Association are growing participation numbers quickly at junior level in China and cite golf and health as their most important topic area. The International Golf Federation's director of inclusion has detailed the impact of collaborations based on research within this thesis on contributing to golf becoming more inclusive.

Table 3 provides an overview of chapters 2-5, and the original contribution to knowledge from this thesis.

Table 3. Overview of chapters 2-5 and contribution to knowledge.

Chapter	Study	Contribution to knowledge
2	Systematically conducted coping review	Summarised existing literature, and priorities for future research Published in peer-reviewed publication.
3	Survey based spectator health studies	Conducted original research assessing motivations for attendance and highlighting that golf spectators can gain Health Enhancing Physical Activity while spectating. Follow up study shows some spectators report increased physical activity 3 months post intervention. Published in peer-reviewed publication.
4	International consensus using Delphi methods	Engaged leaders in health, sport, golf and policy to agree actions for i) golfers/ potential golfers ii) golf industry/ golf facilities iii) policy/ decision makers and iv) the scientific community that if implemented can provide health benefits and minimise dis-benefits of golf. Published in peer-reviewed publication.
5	Maximising and Evaluating uptake, use and impact	Built on existing literature to produce and use a Research Impact (RI) tool. Identified suitable evaluation framework (RCF) and demonstrated uptake, use and impact for golf and health research. Published in peer-reviewed publication.
2-5	All	Identified and used methods that are being applied by other public health/ sports and exercise medicine research teams.

6.2 Interactions between researchers and other stakeholders (for example practitioners, policy makers, and industry).

Collaboration with other academics, practitioners, policy makers, and (golf) industry can be viewed as both a strength and limitation. Building strong relationships and collaborating with stakeholders can aid the conduct of research, and potential implementation but can introduce potential bias.

6.2.1 Relevant other roles

To declare relevant connections and sources of potential bias, I have previously worked full time for the Scottish Government in physical activity and sport, and health policy. During the course of my PhD, I have provided paid work to the Scottish Government and linked organisations for example National Health Service (NHS) Inform. I have also provided input when requested to UK government ministers and civil servants on topics that include golf, health communications, and football. I provided support to the launch of the World Health Organisations Global Action Plan on Physical Activity. Two of my supervisors are based at the Physical Activity for Health Research Centre, where I was also based for my studies. My supervisors and I are paid by the University to investigate physical activity for health, and our work has shown that golf can provide health enhancing physical activity. Professor Nanette Mutrie also provides regular support to the Scottish Government relating to physical activity and health.

I received funding for this research from the World Golf Foundation, who aim to increase interest and participation in golf. I have a paid role as the Chief Medical Officer for the European Tour Golf. The scope of this role is principally providing medical support for elite professional golfers. I also have an unpaid role as a member of the medical commission for the International Golf Federation, and occasionally play golf.

6.2.2 Interaction between academic researchers, golfers, the golf industry and policy makers

My experiences both whilst conducting the academic research within this thesis, and my other roles have led me to reflect on the interactions, associated opportunities, and potential drawbacks of these interactions, and engaged scholarship (Van de Ven & Johnson, 2006).

Golfers/ potential golfers

I spent time speaking with golfers of all ages to better understand the sport and its participants. Sometimes this was informal conversations away from the course, while at other times at courses, driving ranges, or professional tournaments. I have spoken to golfers from over 30 countries during the course of my studies, to gain insight for my research while at other times as part of other roles I have as a doctor and within golf. I have also tried to gain more of an insight of playing the sport myself, playing on average one time per year in the 5 years prior to commencing this research, to playing between 5 and 10 times per year during the research. All of this has helped me better appreciate physical, mental, and social aspects of the sport. It has also ensured, particularly for the International Consensus on Golf and Health that I kept the end-user/ participant in mind where making recommendations which would help keep them practical.

Policy

Having an understanding of public health policy and working with governmental officials in other capacities helped me understand what may interest and add value for them. It has also aided interactions with local and national policy makers in various countries, who are often present at major golf events. Although no funding or formal support external to that provided by the World Golf Foundation was sought for the spectator health studies, the Scottish Government (through Visit Scotland) and other local and national policy makers often contribute their time, expertise, and sometimes financially to events. It is likely that this contributed to adoption of golf and health recommendations. We were committed to publish whatever findings were scientifically supportable although government input could be viewed as a potential source of bias. My work helping with, and providing ambassadorial support to NHS Inform, the most accessed health website in Scotland helped considerably in understanding the need to provide engaging content, and platforms that the science can be shared across in addition to the publishing journal.

Industry

Accepting funding and working with industry (in this case a global golf industry) presents benefits for research conduct and implementation but also a risk of bias. Findings that show golf in a good light may increase interest and participation in the sport, potentially benefitting the likes of the European Tour, The World Golf Foundation, the R&A, and the International Golf Federation financially and reputationally. Upon commencing this research, I identified with my supervisors potential risks of bias which are acknowledged above, and steps to mitigate these which included use of established methods, and a-priori protocols that helped to try and ensure no manipulation of results or selective reporting. It was determined a priori that findings would be submitted for publication regardless of whether findings highlighted

health benefits, dis-benefits or no associations. Initial discussions with the World Golf Foundation were extremely constructive in noting the opportunities to share and act on positive findings, but also taking steps to counter health disbenefits identified. Examples of actions from each of these bodies to mitigate issues identified include

- European Tour- player education and skin cancer screening extended, with players and staff contributing to press information,
- The R&A- launching the golf women and girls charter, to encourage equality and diversity,
- International Golf Federation- funding epidemiological research regarding illness and injury in golf,
- The World Golf Foundation-sharing information and recommendations with golf's global leaders in their industry white papers.

Academic colleagues, publishers and departments

I had the opportunity to interact with a number of research teams, and benefitted considerably from interacting with research groups of varied geography that included UK (GoGolfEurope 2018a,b), the USA (including University of Southern California, and Research Institute of Chicago), and Australia (University of South Australia). Reading the work of research colleagues from different backgrounds, and geographies helped me understand different perspectives, build relationships for future research, and examine my assumptions (Greenhalgh, 2019). This was particularly valuable in building the international consensus on golf and health.

Studies contained in this thesis were published in the British Journal of Sports Medicine (BJSM) and British Medical Journal Open Sports and Exercise Medicine (BOSEM). I have served as a senior associate editor for the BJSM for seven years, and reviewed papers for BMJ Open, BJSM and BOSEM amongst other journals, so am aware of the content and form of articles that are likely to achieve publication for the BMJ group. All of our published articles were subject to independent editorial review and double- or triple-peer review. The peer review process for each of the papers significantly improved the final publication.

Research funding may be more likely to be forthcoming if research shows i) results that are favourable for the field being examined, and ii) strong uptake, use and impact of this work. It is possible that working as a researcher in physical activity for health could potentially bias the findings of our research. In general, 'positive' findings are more likely to be published than studies that show null findings/ no effect (Ioannidis, 2005). We have published all of our findings, but it is feasible that the spectator health research was easier to secure publication

for, than if spectators did not achieve health enhancing physical activity. Regarding evaluation, proving the impact of research is gaining ever increasing importance for career advancement and in securing funding (HEFCE, 2014, 2017). While we described objective metrics related to our research, other elements of our evaluation were more subjective, and could be open to bias (Ioannidis, 2005).

Overall reflections on interactions with other academics, golfers, policy makers, and industry

I have had the opportunity to conduct research, but also to speak to golfers, academic colleagues, policy makers and golf and other sports industry leaders which I feel has improved my understanding of golf and health, and what can practically and feasibly be done.

In Figure 15, I present a simplified overview of interactions between researchers, policy makers, participants, and relevant industry. The arrows reflect information shared from one group to another.

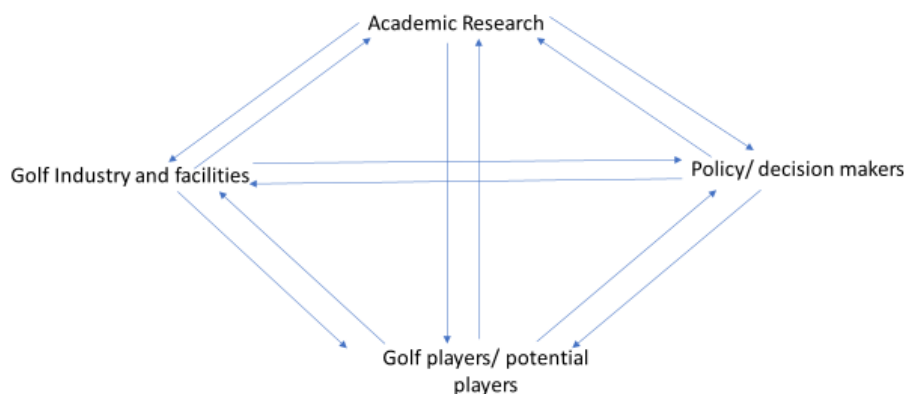


Figure 15. Interactions between researchers, policy makers, participants and industry.

What I found particularly useful, was when a forum such as the 2018 International Congress on Golf and Health, staged at the UK Parliament, High Elms Golf Club, and the Queen Elizabeth II Conference centre permitted all of these groups to interact, collaborate, and challenge each other's assumptions.

Further challenges regarding the interactions between academic researchers and other stakeholder groups have been noted by Dr Tessa Strain, 2018, who I have had the opportunity to discuss this with. These include

- i) Communicating research findings accurately, but presenting them in a form understandable and relevant to the stakeholder group,
- ii) Different timescales that research, policy, and industry operate to (Giles-Corti et al., 2015; Strain, 2018) given differing relative priorities.

Strain, 2018 and others (Brownson & Jones, 2009; Newson et al., 2015) reflect on whether research alone is sufficient to optimally influence policy and practice, or whether stakeholder engagement and dissemination activities add value. They conclude these activities do add value, and I concur with this.

The above reflections on the value of engaged scholarship (Van de Ven & Johnson, 2006, Strain, 2018) may be of value to other researchers in the public health/ sport and exercise medicine field, noting that the World Health Organisation's 2018 Global Action Plan on Physical Activity highlights the value of collaboration in promoting and achieving increased physical activity.

6.3 Future priorities for research and implementation

This thesis has assessed current knowledge regarding golf and health, conducted original research to address knowledge gaps, provided guidance to key stakeholders, and evaluated the uptake, use and impact of our work.

As part of the evaluation (Murray et al., 2019c), I assessed which of the research priorities/ knowledge gaps identified in the scoping review had been progressed further by the scientific community. Building on this, I outline below priorities for future research and action.

Recognising that the scoping review (Murray et al., 2017b), and rapid review (Luscombe et al., 2017) highlighted that golf can provide moderate to vigorous physical activity (MVPA) and contribute to non-sedentary time, the top research priority is to assess golf's contribution to other aspects of World Health Organisation guidelines, and national physical activity guidelines. These comprise i) muscle and bone strengthening and ii) balance improving physical activities (Department of Health and Social Care, 2019; United States Department of Health and Human Services, 2018). Work building on existing knowledge (Luscombe et al., 2017) has been commissioned by The R&A and is underway at the University of Southern California, and the University of Southampton. Small interventional (DuBois et al., 2018) and cross-sectional (Stockdale et al., 2017) studies have been conducted, with an RCT to assess strength and balance in a golf program compared to control underway. Once a fuller picture of golf's contribution to health enhancing physical activity is known, this should be shared systematically with relevant stakeholders, and can be incorporated into policy recommendations and population surveys.

In my view the second key priority is the practical implementation of recommendations of the International Consensus on Golf and Health (Murray et al., 2018a). Actions are already being taken by golfers, the golf industry, policy makers and the research scientists (Murray et al., 2019c), but this momentum should not be lost. Key priorities include

- i) Municipal, local, national and international policies that promote physical activity for health, and interventions that make achieving World Health Organisation PA's recommendations easier. Golf can provide HEPA across the lifespan and can be incorporated into policy, as appropriate to the context. It has a particularly valuable contribution for older adults, who generally are less active than younger persons.
- ii) Increasing accessibility, inclusivity and diversity in golf, and supporting play for all of society. Initiatives to support entry level play, a range of different facilities, and increased participation for women and girls, and those with a disability should be encouraged, facilitated and evaluated. Although increasing physical activity for those

already meeting recommendations has significant health benefits, helping the least active to get up to meeting minimum recommendations offers maximal longevity and wider health gains (Heath et al., 2012, Wen et al., 2011). Golf participation amongst older adults accounts for a greater proportion of achieved physical activity than it does at other stages in life (Strain, 2018), and practical efforts to support ongoing participation include providing support to those with chronic conditions to play golf, and providing golf as an option where practical in exercise referral/ social prescribing schemes.

- iii) Understanding health behaviour change and cost-effectiveness in relation to golf. Evaluations to assess the effectiveness and cost-effectiveness of golf as a health intervention are being conducted, and further larger studies in a range of populations can inform policy and practical implementation. Further work to see how people can be encouraged to for example play more often, and warm up properly and wear sunscreen would be valuable.

A third research priority regards golf and associations between mental health and well-being. While work has been conducted in this domain, further more definitive work is required, in addition to how social aspects of golf/ sport can contribute to health and ongoing participation well into older age.

There are methodological aspects of this thesis that may add value to other sports and exercise medicine/ public health groups. I have assisted various groups including rugby (Griffin et al., 2019), and cricket (Bullock et al., 2019) regarding methods for scoping reviews. I have also assisted tennis, and athletics (Edouard et al., 2019a, b) in their knowledge translation efforts in creating communications assets, and sharing them widely. All of these (rugby, cricket, tennis and athletics) sports research groups have sought advice regarding scientific processes and subsequently collaborated with national, continental or world governing bodies for their sport which they have found helpful in conducting research and implementing findings, while noting risks of research bias.

There remains further opportunities for other sports to conduct research assessing their sport's contribution to physical activity guidelines, and potential public health benefits. Colleagues conducting research in cricket, rugby and football report (via email correspondence) far more studies relating to illness and injury, compared to public health benefits of their sport. Beyond this, there is considerable opportunity to seek consensus around practical public health aspects of their sport. I could not find another sport that has completed this process using an academically rigorous approach, while by comparison

multiple sports have produced consensus on definitions of illness and injury reporting in their sport (Fuller et al., 2006, 2007; Junge et al., 2008; King, Gabbett, Gissane, & Hodgson, 2009; Orchard et al., 2016; Pluim et al., 2009; Timpka et al., 2014; Turner et al., 2012).

6.4 Conclusions

This thesis has assessed current knowledge regarding golf and health, conducted original research to address knowledge gaps, provided guidance to key stakeholders, and evaluated the uptake, use and impact of our work. Methodologies used for the original research projects include: scoping review of the literature; survey, measurement of physical activity with pedometers, Delphi study, co-design, and implementation science methods.

Golf is a sport played by over 60 million persons worldwide and can provide health enhancing physical activity for those across the lifespan. The best available evidence highlights physical health, well-being and probable longevity benefits for participants. Health enhancing physical activity can also be achieved by spectators at professional golf tournaments.

There is evidence of strong uptake and use of the research in this thesis, with >300 published popular press articles, concrete actions by golfers, implementation of teaching programs in the golf industry, and application of recommendations by policy makers. If practical recommendations to i) golfers and potential golfers ii) the golf industry and facilities iii) policy makers iv) the scientific community, are further adopted, this will contribute to improved health through golf.

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Appendices

Addressing the gaps in the literature on the associations between golf and health



Thesis submitted for the degree of Doctor of Philosophy
The University of Edinburgh

Dr Andrew Murray

2020

Addressing the gaps in the literature on the associations between golf and health

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Appendix 1- Abbreviated CV

Andrew Murray
FFSEM, FRCP(Glas), MRCGP, PgC MSK USS, MBChB

Personal Information

E-mail: Docandrewmurray@googlemail.com
Nationality: British
Date of Birth: 12th July 1980
GMC Number: 6072997

Qualifications and Awards (Medical)

2016	Point of Light UK Prime Minister's Award
2016	FRCP(Glas) (conferred)
2015	Scottish Clinical Leadership Fellow.
2015	The Mongolian Government Golden Garelj Award
2014	PRINCE2 Project Management
2014	Edward Jenner Medical Leadership and Management
2014	Fellow of Faculty of Sport and Exercise Medicine
2012	Scottish Health Awards- finalist
2012	Top Outstanding Young Scot (JCI)
2012	Alastair Short Scholarship
2012	Post Grad cert in MSK Ultrasound
2010	Member Faculty of Sport and Exercise Medicine , Edinburgh
2010	MRCGP
2003	MBChB , University of Aberdeen (distinction in all clinical finals)

Current Positions in Medical Professional, National and Regional Bodies

Ambassador- NHS Inform
Vice President- Ramblers Scotland
Consultant- Scottish Government/ NHS Scotland. Health and Wellbeing and Health Futures
Chief Medical Officer- European Tour Golf
Chief Medical Officer- European Tour Performance Institute
Chief Medical Officer- Ryder Cup Europe
Scottish Clinical Leadership Fellow.
Medical Director – European Athletics Indoor Championships 2019
Member- International Golf Federation Medical Commission
Member. International Marathon Medical Directors Association
Physical Activity and Sport advisor- RCPSPG

Employment

2014 to present. Sports and Exercise Medicine, General Practitioner, Specialist Advisor

- PGA European Tour Golf (CMO)- since 2018.
- European Tour Performance Institute (CMO).
- Ryder Cup Europe (CMO)
- University of Edinburgh (research, leadership, and clinical)
- NHS Scotland/ Scottish Government- leadership, health and well-being
- Scottish Rugby Union
- NHS Inform
- Various business/ commercial organisations

2014-2015 Leadership and management fellow, Royal College of Physicians and Surgeons of Glasgow.

8/2011 to 8/2014. Sports and Exercise Medicine, Scotland. Registrar, and Ad Hoc General Practitioner

- Training program in Sports Medicine, Musculoskeletal Medicine, Exercise Medicine, Public Health, Cardiology.
- Heart of Midlothian Football Club. General Practice and Musculoskeletal Medicine
- Scottish Rugby Union. Edinburgh Rugby/ Scottish Rugby Union GP and Sports Medicine
- European Tour Golf. Challenge Tour.
- Scottish Government, Sport and Physical Activity Policy team
- SportScotland Institute for Sport- registrar
- General Practice- Out of Hours and routine GP locum shifts.
- Ad hoc work London Olympics and Paralympics, Tour De France, Diamond League, UK Athletics, Commonwealth Games etc.

8/2010 to 8/2011

- GP locum, and Out of Hours in South East Scotland and Scottish borders.
- Sports Doctor for Kelso races and Marathon Medical Services.
- Sports Medicine and rehabilitation experience with St Johnstone FC, Edinburgh Rugby,
- Chief Medical Officer for expeditions to Indonesia, Mongolia
- I took 3 months off to complete a 2660 mile run from John O'Groats to the Sahara Desert to raise awareness of the benefits of exercise. Raised over £165,000 for various charities with 3 different runs.

8/2007- 8/2010. South East Scotland General Practice Training Scheme

2003- 2007- House Officer jobs, and posts supported for training in Accident and Emergency, and Anaesthetics in Australia, New Zealand, with expedition work worldwide.

Grants, Courses and Certification (selected)

2017	IOC Advanced Team Physician
2011-2019	SCRUMCAPS field of play
2016	Scottish Clinical Leadership Fellow
2014	IRB Medical Educator- Level 1
2013	Advanced Cardiac Life Support- refresher
2012	MSK for GP's- course director
2012	Postgraduate certificate in Musculoskeletal Ultrasound
2011	Basic Echocardiography
2011	Exercise prescription
2010	Doctor as Teacher, GP course, Edinburgh.
2010	Leadership skills GP course, Edinburgh.
2010	Pre Hospital Immediate Care, BASICS, Borders.
2010	Sports Medicine Clinical Skills Course, Bisham Abbey.

Publications (selected)

1. **Murray A**, Costa R. Born to Run. Studying the limits of Human Performance. BMC Medicine. Jun 2012
2. **Murray A**. Physical Inactivity- Getting Scotland on the Move. Br J of Sports Medicine. March 2012
3. Scheer V, **Murray AD**. Musculoskeletal Injuries in Ultra-marathon. Clinical Journal of Sports Medicine, September 2011
4. Scheer V, **Murray AD**, Sports Injuries- Ultra-Marathon. Book Chapter. Prevention, Diagnosis, Treatment and Rehab of Sports Injuries. Springer. 2013.
5. Weiler R, **Murray AD**. Facilitated Physical Activity as a treatment for depressed adults. BMJ. June 2012.
6. Burns H, **Murray AD**. Creating Health through Physical Activity. Br J of Sports Medicine. Dec 2012
7. **Murray A**. Physical Activity for Health. Report of the Chief Medical Officer. Dec 2012. Chapter.
8. Dunlop M, **Murray AD**. Major Limitations in knowledge of Physical Activity Guidelines revealed. Br J of Sports Medicine. Dec 2012.
9. **Murray A**, Murray I, Robson J. Higher, Faster, Stronger- Keeping an evolving game safe. Br J of Sports Medicine. Nov 2012
10. Costa R, **Murray AD**, Thake CD et al. Compromised Energy and Macronutrient Intake of Ultra-endurance Runners During a Multi-stage Ultra-marathon Conducted in a Hot Ambient Environment. International Journal of Sports Science. 2013
11. Costa R, **Murray AD**, Thake D et al. Water and Sodium intake habits of ultra endurance runners. Nutrition Journal. 2013.
12. Dempster S, Britton R, **Murray AD**, Costa R. Case study: Nutrition and hydration status during 4254km of running over 78 consecutive days. IJSNEM. 2013.
13. Gill SK...**Murray AD**, Costa R et al. The Impact of a 24-hours Ultra-Marathon on Salivary Antimicrobial Protein Responses. Int J of Sports Medicine. 2013.
14. Boyce S, **Murray AD**, Jeffrey M. A Review of MSK Ultrasound Training Guidelines and Recommendations for SEM Physicians. Ultrasound. 2013.
15. Costa R, Murray AD. IgG in Ultramarathon runners. 2016.
16. Murray AD, Stephens N. Collaboration is needed to promote the good medicine of exercise. BMJ. 2015
17. Savill B, Murray AD, Weiler R. Increasing physical activity in primary care. Br J of General Practice. 2015.
18. Stewart W, Murray AD, Calderwood C. Turning our children into couch potatoes is not a cure for Sports Concussion. BJSM 2015
19. Murray AD, Calderwood C, O'Connor N, Mutrie N. Scotland's progress in putting physical activity policy into practice. BJSM 2015.
20. Murray AD, et al. The effects and relationships of golf on health: A scoping review protocol. BJSM 2016.
21. Murray AD et al. The relationships between golf and health- a scoping review. BJSM 2016.
22. Murray AD et al. Infographic. The relationships between golf and health. BJSM 2016.
23. Tilley N, Murray AD et al. Infographic. Maximising golf performance. BJSM 2016.
24. Jenkins E, Hawkes R, Murray AD. A scoping review of eye injuries in golf. Journal of Sports Medicine. 2016.
25. Hawkes RA, Malik O, Murray AD. A matter of life and death, health and happiness, or just Olympic gold? BJSM 2016.
26. Dickinson E, Murray AD et al. Hip morphology in elite golfers. BJSM 2016.
27. Scott H, Oliver C, Fawcner S, Murray AD. Why healthcare professionals should know a bit about infographics. BJSM 2016.
28. Osbourne S, Murray et al. Tomorrow's doctors want more teaching on physical activity for health. BJSM 2016.

29. Gates AB, Murray AD. Infographic. Make physical activity a part of daily life at all stages of life. BJSM 2016.
30. Schiphorst C, Murray AD, et al. Infographic. Investments that work for physical activity. BJSM 2016.
31. Scott H, Murray AD. How to make an engaging infographic. BJSM 2016
32. Sanders D, Murray AD, Horwell A. Infographics for student assessments. More than meets the eye. BJSM 2016
33. Oliver CW, Murray AD, MacKenzie G. Virtual attendance at an international physical activity meeting using Twitter - How can data visualisation provide a presence? BJSM 2016.
34. Murray AD, et al. An observational study of spectators' step counts, and reasons for attending a professional golf tournament in Scotland. British Open SEM. 2017.
35. Murray AD, et al. Infographic. Golf spectating and health. BJSM 2017.
36. Murray AD, Hawkes RA. Understanding golf and health. Chapter. Golf Science. Routledge. 2017.
37. Murray IR, Murray AD et al. Infographic. We need minimum reporting standards for biologics. BJSM 2017.
38. Stamatakis M. Murray AD. Bright Spots, Investments that work for physical activity. BJSM 2017.
39. Wang G, Murray AD, Pitsalidis Y. Validation of whole-blood transcriptome signature during microdose recombinant human erythropoietin (rHuEpo) administration. BMC Genomics. 2017.
40. Griffin S, Oliver C, MacKenzie G, Murray AD. Altimetrics- you can't afford to ignore them. BJSM 2017.
41. Luscombe J, Archibald D, Murray AD. A rapid review of golf and physical activity. BMJ Open 2017
42. Murray IR, Murray AD et al. Maximising the impact of your work through infographics. BJR 2017
43. Murray IR, Murray AD. Why surgeons should know and use infographics. BJJ 2017.
44. Murray IR, Murray AD, Infographic. 7 steps to maximise the impact of your work through infographics. BJJ.
45. Campbell A, Calderwood C, Murray AD. Bright sports- the Scottish Walking strategy. BJSM 2018
46. Murray AD, Yousaf H, Campbell A. Scotland leading the way on Active Travel. BJSM 2018
47. Murray IR, Murray AD, Simpson H. Reporting the Right Information for Stem Cell treatment is important. BJR 2018
48. Murray AD, Murray IR... Haddad F. Increasing Research Visibility to Maximise Impact. BJJ 2018.
49. Murray AD... Grant E, Mutrie N. An International Consensus on Golf and Health. BJSM 2018.
50. Murray AD, Glover D, Hawkes RA. Infographics and Digital Resources. An International Consensus on Golf and Health. BJSM 2018.
51. Matthews AG, Preston H, Murray A. Golf and Skin Health: A Narrative Review. Exercise Medicine. 2018
52. Robinson P... Murray A. Systematic Review of Injuries in Professional Golf. Br J Sports Med 2019.
53. Robinson, Patrick G., et al. "Stress fractures: diagnosis and management in the primary care setting." *Br J Gen Pract* 69.681 (2019): 209-300.
54. Murray AD, Kelly P, Morton S. Maximising and evaluating the uptake, use and impact of Golf and Health studies. BJSM 2019.
55. Wells J, Murray AD, et al. "Relationships between Challenge Tour golfers' clubhead velocity and force producing capabilities during a countermovement jump and isometric mid-thigh pull." *Journal of sports sciences* 2019.

56. Murray A, Foster C, Stamatakis E. Let's share, help deliver and sustain the WHO global action plan on physical activity. BJSM (2019): bjsports-2018.

Book chapters

57. **Murray AD**, Running your best- Some Science and Medicine. Lawrie group. (Commercial publication).
58. **Murray AD**, Hawkes R. Science and Medicine for golf professionals. The European Tour. 2014.
59. **Murray AD**, Fiennes R. Running Beyond Limits. Mountain Media. (Commercial publication)
60. **Murray AD**. Farewell to Europe (chapter). Running Home and Away. Edited David Syme. (Commercial publication.)

Editorial/ Reviewer

2012-present- British Journal of Sports Medicine- Senior Associate Editor since 2016.
 2012-present- BMC Medicine- Reviewer
 2012- present- Chief Scientific Office- Reviewer

Presentations

International (selected)

1. Isokinetic International Sports Med Conference. 2019
2. Home of Golf International Partner Gathering. 2019.
3. International Sports Science and Sports Medicine Conference. 2018
4. International Golf and Health Symposium 2018.
5. International Congress on Golf and Health x3.
6. World Scientific Congress on Golf 2016/ 2018. Understanding golf and health. 2016
7. World Congress on Ultra-endurance Sport. Keynote x2. 2016.
8. World Extreme Medicine. Keynote. 2016. 2017.
9. International Society for Physical Activity for Health. 2018.
10. WHO, HEPA Europe. Golf and Health. 2016
11. IOC. Illness and injury prevention in sport. 2014, 2017
12. BASEM/ FSEM annual congress. Multiple.
13. Nutrition in Ultra Endurance Sports. The athletes and practitioners. Plenary. Melbourne 2015
14. Advancing Excellence in Healthcare. Physical inactivity and cancer (parallel session), and panel member, plenary.
15. World Congress on Active Ageing. Opening Address, and chair of session on Stroke and Physical Activity. 2012
16. ICSEMIS. 1) A Commonwealth Games Legacy for Scotland. 2) Faster, Higher, Stronger. 3) Fun Run- do what we say!
17. Return to sport following arthroscopic shoulder stabilization. Murray IR, Murray AD, McBirnie J. EFORT Conference, Madrid, June 2010.
18. Foot Science International Conference. Poland. May 2011. Plenary- Injuries during endurance running.
19. International Convention on Sport and Society. Physical Activity and the Medical Curriculum.

National

1. UK Parliament. X3.
2. Scottish Parliament. Evidence on the benefit of physical activity and sport x10
3. NHS Scotland Conference. Plenary with CMO
4. Scottish Government. X 10.
5. Scottish Parliamentary Cross Party Group for Sport. Exercise is Medicine. 2011, 2012, 2013, 2015, 2016
6. Others in 2013-18 include keynotes at FSEM, RCGP, SSEM, Board for Academic Medicine, RCPE, RCPSG, etc.

Grants as Principal recipient/ investigator

2015 World Golf Foundation \$ 280,000
2012 Alastair Donald Award \$ 12,000

Teaching

- First Aid in Sport, IRB, SRU
- Lecturer, Glasgow University, Edinburgh University. Msc, BSc Sports Medicine.
- Guest lecturer- St Andrews, Aberdeen, Dundee.
- GP Musculoskeletal Medicine course. South East Scotland.
- CSA revision course. Teacher/ facilitator. South East Scotland

Extra-curricular Achievements

- Point of Light. UK Prime Minister's Award. 2016
- Golden Garej Award. The Mongolian Government 2015
- National Adventure Awards. Winner 2016. Finalist 2015.
- Our Heroes Scotland. Finalist 2013
- Overall Winner. Top Outstanding Young Scot 2011 (JCI).
- Outstanding Achievement Award. The Yamaa Trust. 2011.
- Scottish International distance runner. Ranked 1st 50km, 2nd 100km
- World Record for consecutive ultra-marathons
- 1st Place Overall. The North Pole Marathon 2012, Antarctic Ice Marathon 2012, Gobi Challenge 2009, 2012, Indonesian Ultra 2009, the Sahara Race 2009, 6633ultra 2009. Scottish Champs 2013
- Climbed 5 of the "7 summits"- the highest mountain on each continent
- Ran 7 ultra-marathons on 7 continents within a week.
- £170 000 raised for Yamaa trust, SAMH, APCA.
- Represented East of Scotland at tennis, squash, badminton, and cricket.

Other Interests and Experience

- Freelance journalist. Commissioned pieces include for The BBC, The Times, Guardian, The Mail, Geographical.
- Subject of 1 hour documentary, and over 20 Television features.
- Author of book "Running Beyond Limits" publisher Mountain Media.

Referees

Dr Alastair Nicol
Head of Sports Medicine
University of Edinburgh
FASIC
46 Pleasance, Edinburgh

Dr Roger Hawkes
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Appendix 2. List of research publications from PhD study and other relevant publications

Publications within the PhD

1. **Murray A**, Daines L, Archibald D, *et al.* The relationship and effects of golf on physical and mental health: a scoping review protocol. *Br J Sports Med* 2016;50:647-650
2. **Murray AD**, Daines L, Archibald D, *et al.* The relationships between golf and health: a scoping review. *Br J Sports Med* 2017;51:12-19.
3. **Murray AD**, Daines L, Archibald D, *et al.* Infographic. Golf and health. *Br J Sports Med* 2017;51:20-21.
4. **Murray AD**, Turner K, Archibald D, *et al.* An observational study of spectators' step counts and reasons for attending a professional golf tournament in Scotland. *BMJ Open Sport & Exercise Medicine* 2017;3:e000244. doi: 10.1136/bmjsem-2017-000244
5. **Murray AD**, Hawkes RA, Kelly P, *et al.* Do golf fans walk the talk? Follow-up of spectators' beliefs and self-reported physical activity 3 months after they attended a professional golf tournament in the UK. *BMJ Open Sport & Exercise Medicine* 2019;5:e000503. doi: 10.1136/bmjsem-2018-000503
6. **Murray A**, Scott H, Archibald D, *et al.* Infographic. Golf spectating and health. *Br J Sports Medicine* 2018;52:415-416. doi: 10.1136/bjsports-2017-097933
7. **Murray AD**, Archibald D, Murray IR, *et al.* 2018 International Consensus Statement on Golf and Health to guide action by people, policymakers and the golf industry. *Br J Sports Med* 2018;52:1426-14361.
8. **Murray AD**, Barton CJ, Archibald D, *et al.* Infographics and digital resources: an international consensus on golf and health. *Br J Sports Medicine* 2018;52:1421-1425. <https://bjsm.bmj.com/content/52/22/1421>
9. **Murray AD**, Kelly P, Morton S *et al.* Maximising and evaluating the uptake, use and impact of golf and health studies. *Br J Sports Med* 2019.

Other relevant golf and health publications authored/ co-authored by Andrew Murray while working on thesis.

1. **Murray AD**, Hawkes RA. Understanding golf and health. Chapter. *Golf Science*. Routledge. 2017.
2. Luscombe J, Archibald D, **Murray AD**. A rapid review of golf and physical activity. *BMJ Open* 2017
3. Matthews AG, Preston H, **Murray A**. Golf and Skin Health: A Narrative Review. *Exercise Medicine*. 2018
4. Robinson P... **Murray A**. Systematic Review of Injuries in Professional Golf. *Br J Sports Med* 2019.
5. Hawkes RA, Malik O, **Murray AD**. A matter of life and death, health and happiness, or just Olympic gold? *BJSM* 2016.
6. Dickenson E, Ahmed I, **Murray A**, *et al.* Professional golfers' hips: prevalence and predictors of hip pain with clinical and MR examinations. *British Journal of Sports Medicine* 2016;50:1087-1091.
7. Wells J, **Murray AD**, *et al.* "Relationships between Challenge Tour golfers' clubhead velocity and force producing capabilities during a countermovement jump and isometric mid-thigh pull." *Journal of sports sciences* 2019.

8. Tilley N, **Murray AD** et al. Infographic. Maximising golf performance. BJSM 2016.

Other relevant physical activity and health publications authored/ co-authored by Andrew Murray while working on thesis.

1. **Murray AD**, Calderwood C, O'Connor N, Mutrie N. Scotland's progress in putting physical activity policy into practice. BJSM 2015.
2. Savill B, **Murray AD**, Weiler R. Increasing physical activity in primary care. Br J of General Practice. 2015.
3. Osbourne S, **Murray A** et al. Tomorrow's doctors want more teaching on physical activity for health. BJSM 2016.
4. Gates AB, **Murray AD**. Infographic. Make physical activity a part of daily life at all stages of life. BJSM 2016.
5. Schiphorst C, **Murray AD**, et al. Infographic. Investments that work for physical activity. BJSM 2016.
6. Stamatakis M, **Murray AD**. Bright Spots, Investments that work for physical activity. BJSM 2017.
7. Campbell A, Calderwood C, **Murray AD**. Bright sports- the Scottish Walking strategy. BJSM 2018
8. **Murray AD**, Yousaf H, Campbell A. Scotland leading the way on Active Travel. BJSM 2018.
9. **Murray A**, Foster C, Stamatakis E. Let's share, help deliver and sustain the WHO global action plan on physical activity. BJSM 2019.

Other relevant knowledge translation publications authored/ co-authored by Andrew Murray while working on thesis.

1. Scott H, Oliver C, Fawcner S, **Murray AD**. Why healthcare professionals should know a bit about infographics. BJSM 2016.
2. Scott H, **Murray AD**. How to make an engaging infographic. BJSM 2016.
3. Murray IR, **Murray AD** et al. Maximising the impact of your work through infographics. BJR 2017
4. **Murray AD**, Murray IR, Haddad F. Increasing Research Visibility to Maximise Impact. BJJ 2018.
5. Sanders D, **Murray AD**, Horwell A. Infographics for student assessments. More than meets the eye. BJSM 2016
6. Oliver CW, **Murray AD**, MacKenzie G. Virtual attendance at an international physical activity meeting using Twitter - How can data visualisation provide a presence? BJSM 2016.
7. Murray IR, **Murray AD**, Infographic. 7 steps to maximise the impact of your work through infographics. BJJ.

Appendix 3. List of selected presentations discussing Golf and Health findings

- 1) Murray AD, Hawkes. Golf and Health. World Golf Foundation. 2015-2019 (bi-annual).
- 2) Murray AD, Hawkes RA. Understanding Golf and Health. World Scientific Congress on Golf, 2016
- 3) Murray AD, Hawkes RA. Golf and Health. What we know and what we need to know? All-Party Parliamentary Group on Golf, 2016
- 4) Hawkes RA, Murray AD. Is Golf Healthy? World Golf Business Forum, 2016.
- 5) Murray AD. The relationships and effects of golf on health. St Andrews University, 2016-2018.
- 6) Archibald DA, Murray AD. Could golf spectating have health benefits? International Healthy Stadia Conference, 2016.
- 7) Murray AD, Mutrie N, Lundqvist E. Golf and Health. HEPA Europe, 2016. One symposium and one poster.
- 8) Murray AD, Hawkes RA. Golf Development Board. The R&A, 2017-2019.
- 9) Murray AD. Golf and health. China Golf Association, 2017.
- 10) Murray AD. Golf and health. Spanish Golf Federation, 2017.
- 11) Murray AD. Golf and health press conference. Andalusian Open, 2017.
- 12) Murray AD. What we know about golf and health. Research Institute of Chicago/ Shirley Ryan Ability lab. Golf and Health Symposium, 2018.
- 13) Murray AD. What can we do to improve the health of golfers. Research Institute of Chicago/ Shirley Ryan Ability Lab. Golf and Health symposium, 2018.
- 14) Hawkes RA, Murray AD. Golf and Health. Professional Golfers Association of Europe Annual Conference, 2017.
- 15) Hawkes RA, Murray AD. Increasing opportunities to promote golf and health. UK Minister for Public Health, Department for health, Public Health England team, 2018.
- 16) Murray AD. Golf, health, inclusivity and diversity. Scottish Government- Minister for Public Health and Sport, Major events, and Active Scotland teams, 2018.
- 17) Murray AD. Golf, health and maximising performance. International Conference of Sports Medicine and Sports Science, 2018.
- 18) Murray AD, Archibald D, Luscombe J, Hawkes RA. International Society of Physical Activity for Health, 2018. One breakfast meeting, and three poster presentations.
- 19) Murray AD. An international consensus on golf and health. International Conference on Golf and Health, 2018.
- 20) Murray AD. An international consensus on golf and health. UK parliament. 2018
- 21) Murray AD. Golf and health. Emirates Golf Association.
- 22) Murray AD. An international consensus on golf and health. China Golf Association. 2018.
- 23) Murray AD. Golf and health. Hong Kong Golf Association, 2018.
- 24) Murray AD. Consensus on golf and health. Portuguese Golf Federation.
- 25) Glover D, Murray AD, Hawkes RA. Golf and health- what a teaching professional needs to know. Professional Golfers Association of England Annual Meeting, 2018
- 26) Murray AD. Golf and health. What golfers need to know? Craigmiller Park Golf Club, 2018.
- 27) Murray AD. Golf and health. St Andrew's Links Trust/ The Home of Golf, 2019.
- 28) Murray AD. What other sports can learn from golf? Isokinetic International Sports Medicine Conference, 2019.
- 29) Murray AD, Hawkes RA. Improving health through golf. UK Parliament Culture Media and Sport select committee, 2019.

Appendix 4. Scoping Review Protocol. Published BJSM 2016.

https://bjsm.bmj.com/content/50/11/647?utm_source=trendmd&utm_medium=cpc&utm_campaign=bjsm&utm_content=consumer&utm_term=1-A

The relationships and effects of golf on physical and mental health: a scoping review protocol

OPEN ACCESS

1. A Murray^{1, 2},
2. L Daines²,
3. D Archibald³,
4. R Hawkes⁴,
5. L Grant²,
6. N Mutrie¹

Abstract

Introduction Golf is a sport played in 206 countries worldwide by over 50 million people. It is possible that participation in golf, which is a form of physical activity, may be associated with effects on longevity, the cardiovascular, metabolic and musculoskeletal systems, as well as on mental health and well-being. We outline our scoping review protocol to examine the relationships and effects of golf on physical and mental health.

Methods and analysis Best practice methodological frameworks suggested by Arksey and O'Malley, Levac et al and the Joanna Briggs Institute will serve as our guide, providing clarity and rigour. A scoping review provides a framework to (1) map the key concepts and evidence, (2) summarise and disseminate existing research findings to practitioners and policymakers and (3) identify gaps in the existing research. A three-step search strategy will identify reviews as well as original research, published and grey literature. An initial search will identify suitable search terms, followed by a search using keyword and index terms. Two reviewers will independently screen identified studies for final inclusion.

Dissemination We will map key concepts and evidence, and disseminate existing research findings to practitioners and policymakers through peer-reviewed and non-peer reviewed publications, conferences and in-person communications. We will identify priorities for further study. This method may prove useful to examine the relationships and effects of other sports on health.

MAIN PAPER

Introduction/background

Health has been defined by the WHO as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.”¹ It is determined by a range of individual behaviours and characteristic factors, and the physical, social and economic environment that people are subject to.²

Golf is played by around 55 million people,³ representing approximately 1/127 of the global population young and old, in 206 countries worldwide.⁴ Participation in golf affects a number of factors which determine health. Primary research papers^{5–7} and reviews^{8–10} of the literature have described the relationships and effects of golf on aspects of physical health and mental health. These studies have described golf as a valuable form of physical activity,^{7,8} with beneficial lipid profile cardiovascular and longevity associations^{5–7} and mental health benefits.⁸ Studies have also highlighted musculoskeletal injuries including back, wrist and elbow injuries associated with golf,^{10,11} and accidents, for example, eye and head injuries related to ball and club strikes that can occur in a golfing context.^{8,12} However, no study has provided a ‘big picture’ view evaluating the effects and relationships of golf on physical and mental health. The rationale for this scoping review is to conduct a methodologically rigorous study providing this overview, mapping and summarising the evidence, and identifying significant gaps in the literature.

A key theme to emerge is that golf is recognised as a form of physical activity. Regular physical activity is known to prolong life expectancy and positively impact on many physical and mental health conditions.¹³ The most recent Global Burden of Disease study found physical inactivity to be 1 of the 10 leading causes of death worldwide, while its impact is greater in North America, Europe, Australasia and other areas where golf is commonly played.¹⁴ The WHO currently labels physical inactivity as the fourth leading cause of death worldwide,¹⁵ and it has been labelled ‘the biggest public health challenge of the 21st Century’.¹⁶ Physical inactivity is a truly global problem, estimated to be responsible for >5.3 million deaths each year, a number greater than obesity or alcohol excess.¹³ Given the potential physical and mental health benefits, and savings estimated at £0.9 billion¹⁷ per year to the UK National Health Service alone by increasing physical activity, practitioners and policymakers are increasingly interested in further researching the health effects of particular forms of physical activity. Furthermore, initial studies suggest that knowledge of the health benefits of physical activity positively influences people to be active.¹⁸ Initial observation of the literature also highlights the potential negative effects of participation in sport and golf in particular, for example, musculoskeletal injuries and accidents.^{10–12} There may also be relationships between golf spectating and health. Golf is unusual as a spectator sport, typically taking place in a few square miles of arena, with 150+ players to watch, and the opportunity not to be restricted to a designated seat but to walk the course to see the entire

arena¹⁹ or follow players with a potential positive impact on physical activity levels. Hazards for spectators may include being struck by errant golf balls.

A systematic review looking at health benefits related to sport suggested that evidence was strongest for running and football, while ongoing evaluation and research looking at other sports was required.²⁰ A systematic review reported the health benefits of cycling for population health.²¹

Preliminary searches of SportDiscus and Google helped to broaden knowledge of existing literature and shape the formulation of our question. Five relevant reviews were identified, none of which were scoping reviews.^{8–10,22,23} Most notable was a review that looked comprehensively at a range of health outcomes, but did not articulate the methods used.⁸ The remaining articles covered a narrow area in the field of golf and health.

From this process, the primary research question was formulated as ‘What is known about the relationships and effects of golf on physical and mental health?’ We describe a scoping review protocol that is different to previous studies in broadly assessing this topic, and providing clear and robust methodology to examine the relationship and effects of golf on physical and mental health. Once conducted, the scoping review will map the key concepts and evidence, disseminate existing research findings to practitioners and policymakers through peer-reviewed and non-peer reviewed publications, and identify research gaps and priorities for further study. A preliminary search for scoping reviews on this topic has been conducted with no similar study found.

Methods

Scoping reviews typically have a broader research question than systematic reviews.

Systematic reviews search for the best available evidence to answer a narrower question, while scoping reviews can allow investigators to map the extent of research in a given area and share existing findings. Both systematic and scoping reviews can provide a comprehensive and rigorous approach in assessing the available literature, although scoping reviews focus less on the quality of the research. Owing to the wide scope of the research question, scoping reviews map and articulate the available evidence without a formal analysis of the methods or quality of the studies. They map and draw from all useful evidence, as opposed only to the best available evidence used in systematic reviews.

Of the various approaches available for reviewing published and grey literature, a scoping review was felt to be most appropriate to:

- Map the key concepts and evidence available;
- Summarise and share existing research findings with policymakers, practitioners and other relevant stakeholders;
- Identify research gaps in the existing literature.

The methodological framework presented by Arksey and O'Malley²⁴ is well established and frequently used for scoping reviews enabling a clear structure while adding rigour, clarity and reproducibility. Levac et al²⁵ and the Joanna Briggs Institute²⁶ have adapted this process, and these adaptations informed our scoping review protocol.

These frameworks also discuss the need for scoping reviews to be iterative, with those which make adaptations to the research questions, based on initial searches producing best results.

We adopted the five-stage process proposed by Arksey and O'Malley.²⁴

Stage 1: Identify the research question

The research question was framed by assimilating themes from the preliminary searches, and opinions were sought from experts in the field of sports medicine and golf. Using a concept, target population and outcomes of interest approach, we formulated a broad research question: What is known about the relationships and effects of golf on physical and mental health?

Stage 2: Identifying relevant studies

Eligibility criteria

Together, the authors decided on the following inclusion and exclusion criteria to guide the search and review articles found.

Inclusion criteria:

Research articles are not limited by geographical location, language or setting.

All age groups and both sexes of participants.

Research that looks at the general population, as well as at specific population groups (with a specific physical or mental health illness or condition).

All forms of golf (including but not limited to 18 holes, 9 holes, driving range, spectating).

Any physical and/or mental health condition.

Sources of information can include primary research studies, reviews (including but not limited to systematic reviews, scoping reviews, meta-analyses), guidelines, as well as grey literature to include unpublished and ongoing trials, annual reports, dissertations and conference proceedings.

Explicit exclusion criteria identified are:

Opinion pieces/opinions, magazine and newspaper articles, case reports, papers with no data.

Health and safety/occupational issues not related to playing or watching golf.

Search strategy and databases

Step 1: An initial limited search

An initial limited search of SPORTDiscus and Google Advanced Search for review articles was conducted. The search terms used were 'golf' AND 'health' AND 'review'. All 56 studies identified by SPORTDiscus were reviewed, along with the first 200 from the Google search. 26 studies in total proved relevant, with the references from these studies being reviewed for further relevant papers. A search of ProQuest dissertations did not find any similar dissertations.

Step 2: Identify key words and index terms

The title, the abstract and the index terms used to describe the articles identified in step 1 were analysed. The research team identified golf as the only primary research term. For the health-focused databases, namely MEDLINE and PsycInfo, "golf" will be used as the only search term to maximise inclusivity. Secondary search terms will include a broader set of keywords for SPORTDiscus, Web of Science and Google Scholar. Boolean terms AND and OR will help to extract relevant studies, while filtering methods will help in applying exclusion criteria. All relevant articles from SPORTDiscus and Web of Science will be reviewed, with the same search strategy applying to Google Scholar with a pragmatic decision to review only the articles with these terms in the title taken following consultation with a research librarian.

A similar strategy will be applied to the grey literature. The same search terms used for SPORTDiscus, Web of Science and Google Scholar will be applied to search for theses in the ProQuest database. "Golf" as the only search term will be used for the WHO International Clinical Trials Registry Platform. The advanced search function on Google will be utilised to look for relevant reports and articles from the World Golf Foundation, the Royal and Ancient, the British Journal of Sports Medicine, The American College of Sports Medicine and the Faculty of Sports and Exercise Medicine while representatives of these organisations will be contacted for further information.

Step 3: Further searching of references and citations

A search will be conducted of the reference list of relevant identified articles while authors of all relevant primary comprehensive, scoping or systematic reviews will be contacted for further information.

Scoping reviews are typically iterative, as reviewers become increasingly familiar with the research and evidence,²⁴ and thus potentially useful further search terms and sources of information may be incorporated following input from a research librarian.

Search strategies will be documented, and the complete final search strategies are available from the corresponding author. References will be extracted and imported to the Endnote 7 reference management system, where database specific folders will be utilised and duplicates then eliminated.

Stage 3: Study selection

Titles and abstracts identified by the search strategy will be evaluated against the eligibility criteria by one reviewer (AM). A second reviewer (LD) will complete the same process on a random sample of 10% of titles and abstracts as a quality check. The reviewers will assess the title and abstracts independently, using the inclusion and exclusion criteria. If the reviewers disagree on the eligibility of a study, it will be discussed with a third reviewer (DA). If a consensus is not reached, the study will be included in the scoping review. If the same inclusion/exclusion decision is taken by both reviewers for over 95% of studies assessed, then AM will review the titles and abstracts of all other papers. If concordance is less than 95%, then all titles and abstracts will be assessed by both reviewers.

Following this, the full text will be sourced for all articles meeting the inclusion criteria. A PRISMA flow diagram will report numbers once the review has been undertaken.

Stage 4: Charting the data

Extraction of the results

Charting tables similar to that favoured by the Joanna Briggs Institute²⁶ will be used to record and assimilate extracted data from included studies as set out below. The search strategy employed thus far will allow the development of initial a priori categories. Emergent themes will also be charted. Two reviewers (AM and LD) will undertake data extraction duties. A data extraction form will be used to extract details pertaining to study design, methods, participants, interventions and findings. The data extraction strategy will involve AM extracting data from 90% of included studies and LD extracting data from 10% of studies. LD will check 10% of AM's data extractions for accuracy and vice versa. Any disagreements over extracted data will be discussed at group meetings. If significant differences exist, all papers will have data extracted by two reviewers.

- A) Author (s)
- B) Year of publication
- C) Origin (where the study was published/conducted)
- D) Aims/purpose
- E) Study population and sample size (if applicable)
- F) Methodology/methods
- G) Intervention type, comparator, details of these (eg, duration of the intervention) (if applicable)
- H) Duration of the intervention (if applicable)
- I) Outcomes and details of these (eg, how measured, etc) (if applicable)
- J) Key findings that relate to the scoping review research questions

Charting results is commonly an iterative process during scoping reviews; if unforeseen useful data can be charted, then further categories of tables may be added or table headings updated if needed.

Where full papers cannot be obtained, efforts to obtain the full paper via hard or electronic copy via the university library will be made. When the paper cannot be found, we will write to the corresponding author to request it. If the full paper cannot be found, the study will not be included.

Stage 5: Collating, summarising and reporting the results

We envisage that the methods employed in this scoping review protocol will enable us to collate and summarise existing knowledge on this broad topic. On the data being extracted, we will:

- A) Map the key concepts and evidence available;
- B) Summarise existing research findings;
- C) Identify research gaps in the existing literature.

The results will be presented in two parts.

A numerical analysis will map the data in tabular and diagrammatic form, showing distribution of studies by theme, period of publication, country of origin and study method.

A thematic summary will provide a descriptive analysis describing how the research identified relates to the research question and the main findings from these, organised by theme.

Disseminating and communicating results

Ultimately, the scoping review will inform the priority areas for further research, and provide insights into physical and mental benefits and disbenefits associated with golf. Disseminating and communicating these findings widely may help the public and policymakers understand any benefits associated with participation in golf and encourage participation if benefits are found, and also inform on the reduction of risk where disbenefits are highlighted, as well as articulating priority areas for further research.

Findings will be summarised in an account for peer-reviewed publication. A multiplatform approach will be used to help communicate findings with the public and policymakers, the popular and industry press, a newly compiled website (<http://www.golfandhealth.org>) and social media including twitter @golfandhealth and facebook 'Golf and Health' utilised as part of a communication plan. Elite female and male professional and former professional golfers, as well as celebrities with an interest in golf, have volunteered to help communicate key findings using the popular press and social media to build awareness of any potential relationships and effects of golf on physical and/or mental health. The results will be reported

through these mechanisms regardless of whether negative or positive relationships or effects are reported.

Conclusion

Scoping reviews can be particularly effective for addressing widely framed research questions. This scoping review protocol provides rigour and a framework to enable us to look at the relationships and effects of golf on physical and mental health. It will enable us to map the key concepts and insights available, summarise and share existing research findings with all relevant stakeholders and identify research gaps in the existing literature. Scoping reviews provide a useful mechanism for addressing broad questions like the relationships and effects of particular sports on health, and this scoping review protocol may provide a structure that could be utilised by organisations, policymakers and practitioners in other sports or physical activities.

What is known and what this adds

Scoping reviews can provide a useful framework to collate and summarise information on a broad topic.

An evidence-informed overview of the effects and relationships of golf on health is currently lacking.

Golf as a physical activity may have physical and mental health benefits. Potential disbenefits include the risk of musculoskeletal and accidental injuries and skin cancer.

Acknowledgments

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Contributors

AM, LG and NM identified the method, while AM and DA identified existing scoping review frameworks to develop this scoping protocol. AM and LD worked with the team librarian (MD) to develop search terms and a search strategy. All authors have contributed to the development of the research questions and study design. All authors developed the first and subsequent drafts of the manuscript and also reviewed and approved the manuscript.

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Competing interests

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Provenance and peer review

Not commissioned; externally peer reviewed.

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See: <http://creativecommons.org/licenses/by-nc/4.0/>

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Appendix 5. Scoping review. Supplementary file one. Background information.

Online only background information on golf. Supplementary material for Scoping Review, BJSM 2016

What is golf?

Golf is a sport traditionally played on a large open-air course, in which a ball is struck by a club, with the aim of taking the lowest number of strikes possible to get the ball into (traditionally) 18 holes in the ground. The objective of golf is to get the golf ball into the holes in the lowest number of shots. Most commonly played as a round of 18 holes, golf can also be played over 9 holes, or practiced at driving ranges, putting greens and other golfing facilities. Courses can be of varied topography.

Participation

Golf is played by around 55 million people (1) young and old, on 34,011 golf facilities in 206 of 239 countries worldwide (2). Of these facilities, 71% are open to the public, while 79% of facilities are located in the top 10 golfing countries which are largely based in North America, Europe and Oceania (2). Golf facilities are currently strongest in “developed” nations, with a population of 1210 per golf hole in Oceania, compared with 89,229 per golf hole in Africa (2). Health Survey for England 2012 (3) data outlines that 2.2% of persons aged 16 and over reported playing golf in the four weeks prior to the survey, although participation levels are greater in higher socio-economic groups. Scottish Health Survey 2013 (4) data highlights that older golfers play more often than younger golfers. Making golf accessible for all is a key challenge for the golf industry.

How golf compares to other sports

Table 1 below highlights the Metabolic Equivalent of Task (MET) for selected popular sports. For all of these activities, exercise intensity can vary considerably during play, and between individuals. The exercise intensity during golf is lowest when standing waiting for others or putting, and higher when swinging a club or walking.

Table 1. Metabolic Equivalent of Task from 2011 Compendium of Physical Activities (5) for selected sports.

Sport	Golf	Tennis (general)	Football (competitive)	Swimming (light or moderate effort)	Cycling (leisure, 9.4 mph)
METs (3)	4.8	7.3	10.0	5.8	5.8

Few reliable statistics are available comparing global participation in sport. Football is recognised as the most popular sport with an estimated 250 million directly participating(6). The most popular five participation sports in England are shown in table 2.

Table 2. Most popular participation sports in England (7), by volume of participants.

Ranking by participation	England
1	Swimming
2	Athletics
3	Cycling
4	Football
5	Golf

Sources:

1. Farrally MR, Cochran AJ, Crews DJ, *et al.* Golf science research at the beginning of the twenty-first century. J Sports Sci 2003;21:753–65.
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Appendix 6. Scoping review. Supplementary file two. Full search strategy

Searching protocol – electronic databases Scoping Review- Golf and Health
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Step 1

SPORT Discus

1st search: from 1900, all articles, all languages

Search for: Golf AND health

Hits: 1364

2nd search

Search for: Golf AND health AND review

Hits: 56, of which 11 relevant studies identified

Google Advanced

1st search: Golf AND health AND review

Hits: 487,000

First 200 articles reviewed for relevance, 15 appeared relevant

ProQuest dissertations

1st search: Golf AND health

Hits: 4, of which 2 relevant covering narrow aspect of topic.

Reference section of useful studies reviewed.

Step 2

The main category – terms are:

1. Golf
Plus/minus
2. Health OR illness OR injur* OR fitness OR mortality OR morbidity

SPORTDiscus

1st search: from 1900, all articles, all languages

Search for: Golf AND health OR illness OR injur* OR fitness OR mortality OR morbidity

Hits: 3781

2nd search: from 1900, all articles excluding magazine, all languages

Search for: Golf AND health OR illness OR injur* OR fitness OR mortality OR morbidity
excluding magazines

Hits: 744

Web of Science

1 st search: from 1900, all articles, all languages,

Search for: Golf AND health OR illness OR injur* OR fitness OR mortality OR morbidity

Hits: 559

PsycINFO

1st search from 1900, all articles, all languages

Search for: Golf

Topics

Hits: 832

Medline

1st search : from 1900, all articles, all languages

Search for: Golf

Hits: 1721

Google scholar

1st search: from 1900, articles and patents, include citations

Search for: Golf AND health OR illness OR injury OR fitness OR mortality OR morbidity

Hits: 154000, >too many

2nd Search: from 1900, articles and patents, include citations

Search for: Golf AND health OR illness OR injury OR fitness OR mortality OR morbidity

Within title

Hits: 185

Initial database search

Hits: 4041 before duplicates

3167 once duplicates removed

Grey Literature

Google (advanced search)

British Journal of Sports Medicine Domain

1st search: from 1900, all articles, all languages

Search for: Golf AND health OR illness OR injury OR fitness OR mortality OR morbidity AND specify URL <http://bjsm.bmj.com/>

Hits: 548

[https://www.google.co.uk/search?as_q=golf&as_epq=&as_oq=health+illness+injury++fitness++mortality+morbidity+&as_eq=&as_nlo=&as_nhi=&lr=&cr=&as_qdr=all&as_sitesearch=http://bjsm.bmj.com/&as_occt=any&safe=images&as_filetype=&as_rights=&gws_rd=cr&ei=Eq1AVue-](https://www.google.co.uk/search?as_q=golf&as_epq=&as_oq=health+illness+injury++fitness++mortality+morbidity+&as_eq=&as_nlo=&as_nhi=&lr=&cr=&as_qdr=all&as_sitesearch=http://bjsm.bmj.com/&as_occt=any&safe=images&as_filetype=&as_rights=&gws_rd=cr&ei=Eq1AVue-OsfTU6XPtOAC#q=golf+health+OR+illness+OR+injury+OR+fitness+OR+mortality+OR+morbidity+site:http://bjsm.bmj.com/&as_qdr=all&start=20)

[OsfTU6XPtOAC#q=golf+health+OR+illness+OR+injury+OR+fitness+OR+mortality+OR+morbidity+site:http://bjsm.bmj.com/&as_qdr=all&start=20](https://www.google.co.uk/search?as_q=golf&as_epq=&as_oq=health+illness+injury++fitness++mortality+morbidity+&as_eq=&as_nlo=&as_nhi=&lr=&cr=&as_qdr=all&as_sitesearch=http://bjsm.bmj.com/&as_occt=any&safe=images&as_filetype=&as_rights=&gws_rd=cr&ei=Eq1AVue-OsfTU6XPtOAC#q=golf+health+OR+illness+OR+injury+OR+fitness+OR+mortality+OR+morbidity+site:http://bjsm.bmj.com/&as_qdr=all&start=20)

World Golf Foundation

1st search: from 1900, all articles, all languages

Search for: Golf AND health OR illness OR injury OR fitness OR mortality OR morbidity AND specify URL <http://www.worldgolffoundation.org/>

Hits: 11

https://www.google.com/search?as_q=golf&as_epq=&as_oq=health+illness+injury+fitness+mortality+morbidity+&as_eq=&as_nlo=&as_nhi=&lr=&cr=&as_qdr=all&as_sitesearch=http%3A%2F%2Fwww.worldgolffoundation.org%2F&as_occt=any&safe=images&as_filetype=&as_rights=

Royal and Ancient

1st search: from 1900, all articles, all languages

Search for: Golf AND health OR illness OR injury OR fitness OR mortality OR morbidity AND specify URL <http://www.randa.org/>

Hits: 133

https://www.google.com/search?as_q=golf&as_epq=&as_oq=health+illness+injury+fitness+mortality+morbidity+&as_eq=&as_nlo=&as_nhi=&lr=&cr=&as_qdr=all&as_sitesearch=http%3A%2F%2Fwww.randa.org%2F&as_occt=any&safe=images&as_filetype=&as_rights=

Faculty of Sports and Exercise Medicine

1st search: from 1900, all articles, all languages

Search for: Golf AND health OR illness OR injury OR fitness OR mortality OR morbidity AND specify URL <http://www.fsem.ac.uk/>

Hits: 8

https://www.google.com/search?as_q=golf&as_epq=&as_oq=health+injury+illness+morbidity+mortality&as_eq=&as_nlo=&as_nhi=&lr=&cr=&as_qdr=all&as_sitesearch=http%3A%2F%2Fwww.fsem.ac.uk%2F&as_occt=any&safe=images&as_filetype=&as_rights=

American College for Sports Medicine

1st search: from 1900, all articles, all languages

Search for: Golf AND health OR illness OR injury OR fitness OR mortality OR morbidity AND specify URL <http://www.acsm.org/>

Hits 26

https://www.google.com/search?as_q=golf&as_epq=&as_oq=health+injury+illness+morbidity+mortality&as_eq=&as_nlo=&as_nhi=&lr=&cr=&as_qdr=all&as_sitesearch=http%3A%2F%2Fwww.acsm.org%2F&as_occt=any&safe=images&as_filetype=&as_rights=

ProQuest dissertations

1st search: from 1900, all articles, all languages

Search for: Golf AND health OR illness OR injury OR fitness OR mortality OR morbidity

Hits: 42740 >too many

2nd search : Golf AND Health OR illness OR injur* OR fitness OR mortality OR morbidity in title or abstract

Hits: 175 Duplicates 115

World Health Organisation- International Clinical Trials Registry Platform

1st search

Search for: Golf

Hits: 2

<http://apps.who.int/trialsearch/Trial2.aspx?TrialID=NCT02544399> (relevant)

<http://apps.who.int/trialsearch/Trial2.aspx?TrialID=EUCTR2005-003458-81-IT> (not relevant)

Initial Grey Literature Databases search

Hits: 903

Appendix 7. Scoping Review. Supplementary form three. Data Extraction Tool.

<u>1. BIBLIOGRAPHIC INFORMATION</u>	
Study ID	
Article title	
Extracted by	
Type of publication (journal article, book chapter, grey literature)	
Country	
<u>2. RESEARCHER DETAILS</u>	
Authors and affiliations (list as presented on paper)	
<u>3. AIMS & METHODS</u>	
Study aims	
Methodology	
Methods	
<u>4. SCOPING REVIEW PCC</u>	
Population	
Concept	
Context	
<u>5. A PRIORI THEMES (does the paper report any data relevant to the following issues?)</u>	
(a) Golf participation	
(b) Physical Activity & Health	
(c) Golf and physical activity	
(d) Longevity	
(e) Cardio-respiratory	
(f) Metabolic	
(g) MSK	
(h) Accident	

(i) Illness	
(j) Wellness	
(k) Mental illness	
(l) Special populations	
<u>6. EMERGENT THEMES</u> <u>(does the paper report on</u> <u>any further issues not</u> <u>related to the above that</u> <u>might be of interest to this</u> <u>review?)</u>	
<u>(a)</u>	
<u>(b)</u>	
<u>(c)</u>	
<u>(d)</u>	

Appendix 8 -PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) checklist for “the relationships between golf and health: a scoping review”.

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ?
TITLE			
Title	1	Identify the report as a scoping review.	YES
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	Structured summary/ abstract
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	YES
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	YES
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	Protocol published BJSM
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	YES
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	YES, except final date not specified
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	YES, and available in appendix

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ?
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	YES
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	YES
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	YES and data extraction tool provided
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	N/A. Limited critical appraisal as appropriate
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	YES
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	YES
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	YES, except not all citations provided (available on request)
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	Not applicable
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Not practical (>300 included)
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	YES
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	YES
Limitations	20	Discuss the limitations of the scoping review process.	YES
Conclusions	21	Provide a general interpretation of the results with respect to the review	YES

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ?
		questions and objectives, as well as potential implications and/or next steps.	
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	YES

JB1 = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JB1 guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med.* ;169:467–473. doi: 10.7326/M18-0850

Appendix 9. Spectator study one. Participant information sheet.



Participant Information Sheet

Golf spectating and health research project

Please read this information sheet before deciding whether or not to volunteer for this project.

Why is the research being done and what are the benefits?

We are researchers based at the Edinburgh University/ working with the European Tour and we invite you to participate in research which is looking at whether golf spectating can help accrue useful physical activity. Regular physical activity has considerable health benefits. If you agree to participate you will receive information about how much physical activity you have achieved at the event, and information about how this can benefit health. Your participation will also allow us to understand better how to design a much larger study in the future.

A short 5 minute email survey will be conducted after the end of the tournament. Those completing this survey will be entered into a prize draw with the opportunity to win a prize sponsored by the European Tour golf (*most likely a Ryder Cup flag signed by a player*).

What are the aims of the project?

This project is testing practical and feasibility issues of carrying out research among spectators at golf tournaments. We will also

- a) count the number of steps spectators take while at a golf tournament
- b) collect data via a brief follow up e-mail.

We will provide further literature on potential health benefits of spectating and walking to spectators as they leave, and with your permission will send a follow up email, which will take 5 minutes to complete. This data will be anonymised in collection.

Why is the research important?

Regular physical activity helps increase length of life, physical health and mental health. Playing golf has been shown to be beneficial to health. Research is required to see if golf spectating can benefit health. The information collected from this study may be of value in promoting golf spectating, and influencing behaviours of spectators worldwide.

Who are we?

We are researchers with the University of Edinburgh and some of us also work for the European Tour as doctors taking care of the players. We have a track record of working with various sports and governments to promote physical activity and sport, and undertaking research on walking for health.

If I choose to participate, what will I be asked to do?

1. You will be asked to complete and sign a Consent Form. This will let us know that you understand what is involved and that you agree to participate. Then we will ask you to provide us with your name and contact details and a few details of your golf experience. This information will remain confidential to the research team.
2. We will then fit you with a pedometer which is a match box-sized device that accurately measures the number of steps you take, and you may be given some written information.
3. You will be invited to spectate as normal, and hand in your pedometer as you leave the event.
4. About 4 weeks later, we will send you a 5 minute questionnaire via email (or telephone if you would prefer) and ask you to provide us with feedback. There are no right or wrong answers – we are interested in your experiences.

How will the information that is collected be used?

All information collected will be confidential and names will be removed in any use of the information. The results will be fed back to the European Tour and will be submitted for publication in a research journal. A plain language version of the results will be available which may be picked up in the media. We will send results to any participant who is interested. Anonymised information may be retained to support further research.

If you have any questions or enquiries at anytime before, during and after the study please feel free to contact us: Dr Andrew Murray docandrewmurray@googlemail.com) or Kieran Turner (E-mail: kieran.turner26@googlemail.com);

Participants are free to withdraw from the study at any time without being disadvantaged in any way. Taking part or not taking part in this study has no impact on attending the golf event [other than you will receive literature on health benefits of spectating signed by a leading golf professional].

Appendix 10. Spectator study. Participant consent form



Golf spectating and health – *Why do you do it and what is in it for me??*

The main aims of the study are to investigate whether useful physical activity (which can benefit health) can be obtained while spectating at a golf tournament. You will receive information about how you can benefit your health while spectating, and a souvenir when returning the pedometer. You will be entered into a prize draw for prizes signed by professional golfers if you are happy to fill in a 5 minute email follow up.

CONSENT- please read info sheet also

If you volunteer for this study you will be asked to:

1. Fill in a no more than 5 minute interview form, and wear a pedometer (a device that measures the steps you take). A researcher will collect the pedometer on your way out of the event, and will provide of information relating to walking and health.
2. Fill in a (no more than 5 minute) email form online.

Your participation in this study is voluntary and you have the right to withdraw at any time during the study. All participant's information and results gathered throughout the study will be kept confidential and be viewed only by the research team. In subsequent use of the collected information any details that may identify you will be removed. All your results and information will be made available to you on request. Data may be pooled with other current or future data.

Physical activity is overall beneficial for health, but occasionally complications/ medical incident can result from this. By participating I will not hold liable the research team for any medical incident, and do not have any unstable heart conditions.

If you have any questions or enquiries at anytime before, during and after the study please feel free to contact us: Dr Andrew Murray (E-mail: docandrewmurray@googlemail.com ; 07791303980 or Kieran Turner (E-mail: Kieran.turner26@googlemail.com) XXXXX (number provided)

If you consent to participate in this study, please fill in your details below.

I (Name)..... have read and fully understood the above information, I understand that I am free to withdraw from the study at anytime, with out being disadvantaged in anyway and hereby give my consent to participate in this study.

Signed..... Date.....

Contact phone number:

Email address :

Appendix 11. Spectator study one. Full questionnaire



Spectator Questionnaire

Many thanks for taking the time to fill in this questionnaire. Answers will be used for research only and will not be passed on to any third parties. Your answers will be confidential. We will email you in 4 weeks and ask you to fill a (maximum 5 minute) follow up questionnaire.

Name
Email address
Contact phone number
Date of birth
Male / Female

Number of golf events attended before as a spectator (please circle one)

None 1-2 3-5 6-10 11-20 21-50 over 50

Number of occasions per year when you play golf (please circle one)

None 1-2 3-5 6-10 11-20 21-50 over 50

Your reasons for spectating.

Please rate each reason for importance from 1 (for no importance) to 10 (of extremely high importance).

1) Watch star players

1 2 3 4 5 6 7 8 9 10

2) Learn from star players

1 2 3 4 5 6 7 8 9 10

3) Non-golfing entertainment

1 2 3 4 5 6 7 8 9 10

4) Atmosphere

1 2 3 4 5 6 7 8 9 10

5) Fresh air

1 2 3 4 5 6 7 8 9 10

6) Exercise/ Physical activity

1 2 3 4 5 6 7 8 9 10

7) Time with friends/ family

1 2 3 4 5 6 7 8 9 10

Please specify below other reasons for spectating (free text)

Thank you for completing this survey

Appendix 12. Spectator study 2. Full questionnaire.



This short survey is investigating the importance that golf spectators place on walking/ physical activity, and the potential to influence spectators' knowledge and behaviours through providing information at golf events. It is not a test, we are interested in knowledge, and the value of promoting walking at golf tournaments.

There are 10 questions and this should take no longer than 5 minutes to complete.

Please complete all questions on your own as best you can.

By completing I give my consent for my anonymous responses to be used for reports and appropriate scientific outputs. The questionnaire is entirely voluntary. Some information on the golf and health project is shown at www.golfandhealth.org

Questionnaire

- 1) How many steps (as a minimum) per day are generally recommended in guidelines as being beneficial to health?

5000
10000
15000
20000

- 2) Which of the following physical activities can be beneficial for health? Please tick one box only.

Playing golf
Taking the stairs
Walking to work
All of the Above

- 3) The UK Chief Medical Officers physical activity guidelines for adults state: (Fill in the number of minutes that corresponds to the blank space). Over a week, physical activity should add up to at least _____ minutes of moderate intensity activity per week

30 minutes
60 minutes
150 minutes
300 minutes
450 minutes

- 4) Walking while spectating at golf events is likely to be beneficial for health. How much do you agree with this statement. Please tick one:

Strongly agree
Agree
Neither agree or disagree
Disagree
Strongly disagree

- 5) Receiving information at the Paul Lawrie European Tour event about the benefits of walking/ physical activity helped increased my knowledge in this area: How much do you agree with this statement. Please tick one:

Strongly agree

Agree
Neither agree or disagree
Disagree
Strongly disagree

6) Receiving this information will make me consider being more physically active at golf tournaments? How much do you agree with this statement. Please tick one:

Strongly agree
Agree
Neither agree or disagree
Disagree
Strongly disagree

7) Receiving this information has made me consider being more physically active in daily life. How much do you agree with this statement? Please tick one box only:

Strongly agree
Agree
Neither agree or disagree
Disagree
Strongly disagree

8) I have done more physical activity (including walking) since spectating at the Paul Lawrie golf tournament? How much do you agree with this statement. Please tick one box only:

Strongly agree
Agree
Neither agree or disagree
Disagree
Strongly disagree

9) Being provided with information about potential health benefits of spectating make it more likely I will attend a golf tournament? How much do you agree with this statement. Please tick one box only:

Strongly agree
Agree
Neither agree or disagree
Disagree
Strongly disagree

10) Which of the following would be the most useful way to give golf spectators information about the benefits of walking the course?

Strongly agree
Agree
Neither agree or disagree
Disagree
Strongly disagree

Appendix 13. International Consensus on Golf and Health. Protocol.

Title Page

International consensus statement on golf and health to guide action by people, policy makers and the golf industry: protocol

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Keywords: physical activity, golf, health, public health, injury.

ABSTRACT

INTRODUCTION

There has been a recent increase in scientific and public/popular interest relating to golf and health. We aim to engage leaders in health, policy, sport and golf to build a cross sectoral agreement relating to golf and health. Specifically, using the best available evidence to inform a Delphi expert consensus process, we aim to achieve consensus on i) types of health benefits that golf offers ii) how individuals and populations can improve their health through playing golf or spectating at events iii) how illness/ injuries related to golf can be minimised and iv) how the golf industry, and policy makers can work together to increase opportunities to gain health benefits through golf. Players, potential players and spectators stand to benefit from a better understanding of how to realise potential health benefits, and minimise health issues related to golf, while policy makers can raise awareness and support potential public health benefits, and the golf industry can benefit from potential increased interest and participation in the sport. We outline our protocol for an international consensus on golf and health, utilising Delphi methodology.

METHODS AND ANALYSIS

The need for a consensus statement on golf and health was established by the World Golf Foundation's Golf and Health executive board members in 2017, following the publication of a scoping review. A working group of 4-6 persons will search published and unpublished literature identifying information items relating to golf and health that experts can rate in the Delphi process. This search will build on a 2016 Scoping Review of Golf and Health, examining key issues in more depth. The most relevant information will be developed for a Delphi study. An expert group of 15-25 persons from leading health organizations, sport and physical activity policy makers, educational institutions, and golfing organizations will take part in serial surveys to establish consensus on whether items should be included within the final consensus statement. In addition to rating agreement, experts will be encouraged to suggest refinements or additions after each survey. Pre-defined criteria will be used to refine survey content between each round established standard Delphi methods.

PUBLICATION AND COMMUNICATION

We are committed to publish findings in a peer reviewed journal. We will share key findings with key stakeholders including the World Golf Foundation and its constituent members. These findings will also be shared more widely via in-person communications, at conferences, and through the popular press and social media.

INTRODUCTION

Golf is a sport played by over 50 million people on six continents worldwide (1, 2). There has been a recent increase in scientific and popular interest relating to golf and health. A systematically conducted scoping review published in 2016 described a decade on decade increase in scientific papers pertaining to golf and health (3, 4). This review generated considerable engagement, scoring in the top 0.01% by Altimetric, and prompting over 100 popular press articles. This review, and others (5) highlight that golf can provide physical activity to persons across the life span, and may be associated with longevity (6), physical health (7, 8) and wellness benefits (9, 10). Conversely, negative health outcomes including injury (11, 12), and an increased risk of skin cancer (13) have been associated with playing golf.

While scientific knowledge is advancing, it is unlikely that potential participants in golf, current players, spectators, policy makers and the golf industry will have the time or resources to collate evidence themselves on how health benefits associated with the sport can be accrued, and how risks can be avoided or mitigated.

In light of this, the objective of this study is:

- To engage leaders in the intersection of health, sport, policy and golf to build a cross-sectoral agreement relating to golf and health- promoting an improved understanding of major issues relating to golf and health.
- Specifically, we aim to achieve consensus on i) health benefits that golf is associated with ii) how individuals and populations can improve their health through playing golf or spectating at events iii) how illness/ injuries related to golf can be minimised and iv) how the golf industry, and policy makers can work together to increase opportunities to gain health benefits through golf

Players, potential players and spectators stand to benefit from a better understanding of how to realise health benefits, and minimise health issues related to golf, while policy makers can raise awareness and support potential public health benefits, and the golf industry can benefit from potential increased interest and participation in the sport.

We outline our protocol for an international consensus on golf and health to guide participants, spectators, policy makers and the golf industry, utilising Delphi methodology.

METHODS AND ANALYSIS

The requirement and ambition for expert consensus was established by the World Golf Foundation, Golf and Health project board through iterative discussions in 2017. Appointing a working group of individuals with existing knowledge in this area was considered the best approach to initiate the development of a consensus framework.

The Delphi method is a well-accepted, rigorous and systematic method for achieving consensus of opinion of experts and identifying priorities on real-world issues (14). These methods can assist in drawing on the best available evidence, and the opinions and experiences of individuals and the organisations they represent. The format, and use of electronic/ remote collection of data can obviate undue influence of potentially dominant individuals, and lower barriers presented by international travel and communication which can produce bias in a consensus process depending on who can attend and the language they speak.

Methods were developed by Dalkey and Helmer (15) in the 1950's and have been refined and adapted successfully in a range of settings including healthcare, sport, and policy (16-21). Delphi methods are an appropriate tool for engaging leaders in health, sport, policy and golf to build a cross-sectoral agreement relating to golf and health- promoting an improved understanding of major issues relating to golf and health

Dalkey and Helmer (15) provided a framework frequently used for Delphi studies. This work has been discussed, utilised and refined by Hasson, Keeney and McKenna (18), Hsu and Sandford (14), Akins Tolson and Cole (22), Ludwig (23) and Diamond et al (24), whose iterations suited their respective applications. These works all describe an iterative series of questionnaires, that allow an expert group to re-score based on the usually anonymised feedback of the group.

We will use a series of questionnaires to collect data from the selected expert group (14), with appropriate feedback and statistical analysis enabling a robust and transparent process. Authors report that three iterations or "rounds" are frequently sufficient to collect required information and reach consensus (14, 23), with 75% agreement being the median threshold agreement to define consensus (24), with <10% disagreement. We will utilise three rounds unless stability of items meeting criteria (>85%) is not achieved, in which case further rounds may be required (24).

Preliminary Work and Selection of Working Group

Where useful published and unpublished literature exists on a subject area, a well-accepted modification of Delphi processes is to review this literature and provide a framework and structured questionnaire for round one of the formal Delphi process (14). Preliminary work will be conducted by a working group (WG) who will update a previously conducted systematic search of the literature. The preliminary work will also review relevant guidelines and policy documents. To maximise objectivity and inclusivity, this group will comprise four to six highly experienced persons, with at least one representative from each of the following domains:

- i) Public health/ physical activity for health policy
- ii) Golf and health subject area
- iii) Golf industry
- iv) Golf participant
- v) Delphi/ Consensus methodology

Potential working group members are shown in Appendix 1

Generation of Survey

Following an analysis of the updated search, relevant guidelines and policy documents, and where relevant discussion with topic experts, a framework for building a golf and health consensus will be developed using relevant domains and headings.

Each domain/ heading will be populated with potential items for inclusion in the proposed survey. A draft survey will be generated using Survey Monkey (San Mateo, USA), which will be assessed for content and understandability by all members of the working group, and appropriate modifications made.

Selection of Expert Group Selection

Selecting experts with a sufficient breadth and depth of knowledge is critical in the conduct of a successful Delphi study (14, 20). Existing methodological frameworks do not define precise criteria for selection, but outline that expertise must be related to the subject in question, and that they must be willing and able to engage in a process that can be time intensive (14).

The working group will engage with all invited contributors to the 2018 International Golf and Health Conference. A committee comprising executives from the International Society for Physical Activity for Health (ISPAH), the World Golf Foundation (WGF), the R+A, and the

Faculty of Sports and Exercise Medicine (FSEM) had identified and invited individuals with an interest and knowledge in

- Public health/ physical activity for health policy
- The golf and health subject area
- The golf industry

It is anticipated that between 15 and 25 persons will be invited to form an expert group aiming to utilize the Delphi method to reach consensus on key issues. While the majority of Delphi studies have used between 15 and 20 respondents (23)(24), studies using 9 to 23 experts have been shown to yield stable, reliable results (21, 22) while allowing concentrated expertise, and reduced attrition. The literature does not reach consensus on an optimum number of panelists, but several respected studies have proceeded successfully with a similar number (21, 22). We will be pragmatic depending on the responses of invited contributors to the 2018 International Golf and Health Conference regarding numbers forming the expert group.

Experts will be sent an email introducing the concept and providing a participant information leaflet. Appropriate consent to participate in the expert group. A total of two reminder emails will be sent to those not responding initially.

Rounds of Questionnaires

Round one

An initial questionnaire will be circulated to experts using Survey Monkey (San Mateo, USA) with an introduction and instructions. Each member of the expert group will be asked to assess proposed based on the preliminary work of the working group.

Each will be invited to grade each item on a nine point Likert scale (reference Likert 1932) (“strongly agree”, to “strongly disagree”), and to suggest items and make comments that they think would add value to the next iteration of the questionnaire.

Reminder emails will be sent to those that do not respond initially. A researcher (AM) and a second member of the working group, will collect, edit and summarise findings.

Round two

As per existing best practice, the expert groups’ collective findings, and anonymised individual EG members responses will be fed back to the EG allowing members to appreciate opinions of other persons, and their reasons for their position (23).

Items scoring >60% agreement (rating 7 or above on the nine-point scale), will be included in the questionnaire for round two. In keeping with existing best practice, modifications to existing items may be incorporated following review of all EG comments from stage one(14), while additional items suggested during round one will be added to the questionnaire, and emailed to (the same) EG members. Participants will be invited to re-score each item on the Likert scale, provide additional comment, and where relevant clarify reasons if they remain out-with the consensus for an item.

Round three

The survey process will be repeated for 3 rounds or until consensus has been reached (stability of items meeting criteria >85%) (24).

The EG’s collective findings, and anonymised individual EG responses will be fed back to the EG allowing members to appreciate opinions of other persons, and the reasons for their position (23)

Data analysis

PUBLICATION AND COMMUNICATION

Time-line of activities

Acknowledgements

Contributors AM, PK, LG, IRM and NM identified the method and existing Delphi frameworks to develop this study. All authors will contribute to the development of outline study design, and the conduct of the study.

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Potential panel members

AM- Primary author of recently systematically conducted scoping review

PK- Nominated executive board member, International Society PA for Health

NM- Golfer, and policy advisor, Scottish Government, active Scotland.

IM- Methodology expert, Delphi Studies/ Consensus statements.

KB/ JD- Director/ Deputy Director- Golf Development, the Royal and Ancient.

VM- Professional golfer and industry expert.

Appendix 14. International Consensus on Golf and Health. Full Search Strategy.

Searching protocol – electronic databases Consensus Statement- Golf and Health

Step 1 (September 2015)

SPORT Discus

1st search: from 1900, all articles, all languages

Search for: Golf AND health

Hits: 1364

2nd search

Search for: Golf AND health AND review

Hits: 56, of which 11 relevant studies identified

Google Advanced

1st search: Golf AND health AND review

Hits: 487,000

First 200 articles reviewed for relevance, 15 appeared relevant

Reference section of useful studies reviewed.

Step 2 (September 2015)

The main category – terms are:

3. Golf
Plus/minus
4. Health OR illness OR injur* OR fitness OR mortality OR morbidity

SPORT Discus

1 st search: from 1900, all articles, all languages

Search for: Golf AND health OR illness OR injur* OR fitness OR mortality OR morbidity
excluding magazines

Hits: 3781

2nd search: from 1900, all articles excluding magazine, all languages

Search for: Golf AND health OR illness OR injur* OR fitness OR mortality OR morbidity

Hits: 744

Web of Science

1 st search: from 1900, all articles, all languages,

Search for: Golf AND health OR illness OR injur* OR fitness OR mortality OR morbidity

Hits: 559

PsycInfo

1 st search from 1900, all articles, all languages
Search for: Golf
Topics
Hits: 832 -> Excluding by title or abstract -> X out of XXX

Medline

1st search : from 1900, all articles, all languages
Search for: Golf
Hits: 1721 -> Excluding by title or abstract ->X out of the XXXX

Google scholar

1st search: from 1900, articles and patents, include citations
Search for: Golf AND health OR illness OR injury OR fitness OR mortality OR morbidity
Hits: 154000, >too many

2nd Search:from 1900, articles and patents, include citations
Search for: Golf AND health OR illness OR injury OR fitness OR mortality OR morbidity
Within title
Hits: 185

Initial databases search

Hits: 3963 before duplicates
3267 once duplicates removed

Grey Literature

Google (advanced search)

1st search: from 1900, all articles, all languages
Search for: Golf AND health OR illness OR injury OR fitness OR mortality OR morbidity AND
specify URL from World Golf Foundation OR Royal and Ancient OR Faculty of Sports and
Exercise Medicine OR British Journal of Sports Medicine

Proquest

1st search: from 1900, all articles, all languages
Search for: Golf AND health OR illness OR injury OR fitness OR mortality OR morbidity

Cochrane trials (Marshall)

1st search
Search for: Golf
Topics
Hits

World Scientific conference on golf

Hand search of 2014 World Scientific Conference on Golf conference proceedings
1st search: xxx articles

Step 3- updated search to cover period from end of scoping review search to present day (September 2015 to July 2017)

The main category – terms are:

1. Golf
Plus/minus
2. Health OR illness OR injur* OR fitness OR mortality OR morbidity

SPORT Discus

1st search: from Sept 2015 to July 2017, all articles excluding magazines, all languages
Search for: Golf AND health OR illness OR injur* OR fitness OR mortality OR morbidity
excluding magazines

Web of Science

1st search: from Sept 2015 to July 2017, all articles, all languages,
Search for: Golf AND health OR illness OR injur* OR fitness OR mortality OR morbidity
Hits:

PsycInfo

1st search from Sept 2015 to July 2017, all articles, all languages
Search for: Golf
Topics
Hits:

Medline

1st search from Sept 2015 to July 2017 , all articles, all languages
Search for: Golf
Hits:

Google scholar

1st Search: from Sept 2015 to July 2017 , articles and patents, include citations
Search for: Golf AND health OR illness OR injury OR fitness OR mortality OR morbidity
Within title
Hits: 185

Initial databases search

Hits: before duplicates
once duplicates removed

Grey Literature

Google (advanced search)

1st search: from Sept 2015 to July 2017, all articles, all languages

Search for: Golf AND health OR illness OR injury OR fitness OR mortality OR morbidity AND specify URL from World Golf Foundation OR Royal and Ancient OR Faculty of Sports and Exercise Medicine OR British Journal of Sports Medicine

Proquest

1st search: from Sept 2015 to July 2017, all articles, all languages

Search for: Golf AND health OR illness OR injury OR fitness OR mortality OR morbidity

Cochrane trials

1st search

Search for: Golf

Topics

Hits

World Scientific conference on golf

Hand search of 2016 World Scientific Conference on Golf conference proceedings

1st search: 8 articles

Appendix 15. International Consensus on Golf and Health. Supplementary file. Expert Panel members

Expert Panel members

Dr Daryll Archibald. Lecturer. Public Health. LaTrobe University. Melbourne.

Prof Wade Aubry. Professor of Medicine, and core faculty Institute for Health Policy Studies, University of California.

Tony Bennett. Director. European Disabled Golf Association.

Anthony Blackburn. Founder. Golf in Society, United Kingdom.

Dr Stuart Biddle. Professor of Physical Activity for Health. University of Southern Queensland.

Glenn Cundari. Lead Organiser. 2018 World Scientific Congress of Golf. Technical Director, Professional Golf Association of Canada.

Jackie Davidson. Deputy Director of Golf Development. R&A. St Andrews.

Dr Jose Antonia Doniari. Chief Medical Officer. Royal Spanish Golf Federation. Madrid.

Dr Charlie Foster. President, International Society of Physical Activity for Health.

Prof Liz Grant. Director Global Health Academy and Assistant Principal for Global Health, University of Edinburgh.

Dr Roger Hawkes. Executive Director, Golf and Health. World Golf Foundation, St Augustine, Florida. Member International Golf Federation medical committee.

Dr Tom Hospel. Chief Medical Officer for the Professional Golf Association Tour, and the United States Golf Association.

Dr Prakash Jayabalan. Physician Scientist. Shirley Ryan Ability Lab, and Assistant Professor, North-western University, Chicago.

Val Melvin. International level golf player, and golf industry leader.

Dr Andrew Murray. Consultant in Sports Medicine, University of Edinburgh. Chief Medical Officer, European Tour Golf.

Prof. Nanette Mutrie. Policy Advisor, Scottish Government and Director of Physical Activity for Health Research Centre, University of Edinburgh.

Ian Randell. Chief Executive. Professional Golf Association of Europe.

Dr George Salem. Associate Professor/Director, Anatomical Sciences, University of Southern California.

Dr Kevin Scheepers. Consultant in Sports Medicine and General Practice. Managed Health. Johannesburg.

Dr Dinesh Sirisena. Sports and Exercise Medicine consultant. Khoo Tech Puat Hospital, Singapore.

Jason Stanton. Operations Director. MyTime Active. United Kingdom.

Bradley Stenner. Lecturer. School of Health Sciences. University of South Australia.

Prof Maria Stokes OBE. Professor of Musculoskeletal Rehabilitation, University of Southampton.

Frank Thomas. Founder, Frankly Golf. Former Technical Director, United States Golf Association.

Dr Rehema White. Lecturer, Department of Geography and Sustainable Development.

Appendix 16. Final consensus statements, and detailed levels of agreement

DOMAIN 1: GOLF'S ASSOCIATIONS WITH HEALTH AND MECHANISMS

a. Relationship of golf with health outcomes

Question No.	Item	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree	% Agree/ Strongly Agree
1	The best available evidence suggests playing golf regularly is associated with increased longevity	0.00%	0.00%	0.00%	52.00%	48.00%	100.00%
2	Playing golf regularly can improve known risk factors for cardiovascular disease (for example blood lipids, and body composition)	0.00%	0.00%	0.00%	68.00%	32.00%	100.00%
3	As a physical activity, golf is likely to reduce the risk of chronic conditions including cardio-vascular disease, type 2 diabetes, colon and breast cancer, depression and dementia	0.00%	0.00%	4.00%	60.00%	36.00%	96.00%
4	Playing golf is associated with mental well-being benefits which can include improved self-esteem, self-worth, self-efficacy and social connections.	0.00%	0.00%	0.00%	52.00%	48.00%	100.00%
5	Playing/ involvement with golf can positively influence health for individuals with disability	0.00%	0.00%	0.00%	54.17%	45.83%	100.00%
6	Playing golf can contribute to healthy and active ageing, providing physical and mental health, cognitive, social, functional and other benefits	0.00%	0.00%	0.00%	32.00%	68.00%	100.00%
7	The annual incidence of injury playing golf is moderate compared to other sports , while the risk of injury per hour played is low compared to other sports	0.00%	0.00%	4.00%	56.00%	40.00%	96.00%
8	Serious injury is rare, although accidental head injury sustained from being struck by a ball or club can have serious consequences	0.00%	4.00%	0.00%	52.00%	44.00%	96.00%
9	While moderate sun exposure can offer benefits, golfers can be exposed to increased risk of skin cancer associated with excess sun exposure if appropriate care and consideration is not taken.	0.00%	0.00%	0.00%	64.00%	36.00%	100.00%
10	The magnitude of health benefits/ health problems will depend upon many factors including age, gender, genetic factors and the existing fitness/ wellness of the participant, the topography of the course, and frequency of play.	0.00%	0.00%	0.00%	52.00%	48.00%	100.00%
11	While a significant body of evidence exists relating to golf and health, further high quality research is needed	0.00%	0.00%	0.00%	48.00%	52.00%	100.00%
12	High quality research is needed to assess relationships between golf and mental health/ well-being, the contribution of golf to muscle strength and balance, benefits to particular populations, and to explore cause and effect nature of associations between golf and health.	0.00%	0.00%	4.00%	44.00%	56.00%	100.00%

b. Mechanisms to achieve health

Question No.	Item	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree	% Agree/ Strongly Agree
13	Golf can provide health enhancing physical activity for persons of all ages	0.00%	0.00%	0.00%	36.00%	64.00%	100.00%
14	Playing golf can provide moderate intensity aerobic physical activity	0.00%	0.00%	0.00%	40.00%	60.00%	100.00%
15	The relative intensity of physical activity while playing golf can vary with topography and length of the course, environmental conditions, and the age, gender and baseline fitness of the participant	0.00%	0.00%	0.00%	28.00%	72.00%	100.00%
16	Health benefits are likely greater for those walking the course as opposed to riding a golf-cart (for those that are able).	0.00%	0.00%	0.00%	28.00%	72.00%	100.00%
17	Benefits accrued by those playing golf riding a golf-cart may include health enhancing physical activity, social connections and green exercise while the intensity of physical activity is lower compared to those playing and walking the course.	0.00%	4.00%	4.00%	52.00%	40.00%	92.00%
18	Playing golf is likely to provide strength and balance benefits for older adults	0.00%	0.00%	0.00%	70.83%	29.17%	100.00%
19	Spectating in an active fashion (for example walking the course) at golf courses/tournaments offers an opportunity for health enhancing physical activity	0.00%	0.00%	0.00%	60.00%	40.00%	100.00%
20	Playing golf outside can provide a form of green exercise and nature connection which can be enhanced in naturalistic courses.	0.00%	0.00%	0.00%	56.00%	44.00%	100.00%
21	Golf offers opportunities for intergenerational connection, for social interaction and to support communities with events of interest.	0.00%	0.00%	0.00%	44.00%	56.00%	100.00%
22	Taking part in physical activity additional to golf is likely to offer golfers further health benefits.	0.00%	0.00%	0.00%	36.00%	64.00%	100.00%

c. Dose and effect

Question No.	Item	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree	% Agree/ Strongly Agree
23	Adults should do at least 150 minutes of moderate-intensity aerobic physical activity (which could include golf) throughout the week or do at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week or an equivalent combination of moderate and vigorous-intensity activity to meet World Health Organisation recommendations.	0.00%	0.00%	0.00%	52.00%	48.00%	100.00%
24	Participation in golf/ other physical activities over and above the minimum Physical Activity guidelines, is likely to offer additional benefits compared to those just reaching the minimum recommendations.	0.00%	0.00%	4.00%	44.00%	52.00%	96.00%
25	Being physically active/ playing golf regularly throughout life provides greater benefits than being active/ playing golf intermittently	0.00%	0.00%	0.00%	36.00%	64.00%	100.00%

DOMAIN 2: CORRELATES, DETERMINANTS, DIVERSITY AND SUSTAINABILITY

a. Behavioural patterns

Question No.	Item	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree	% Agree/ Strongly Agree
26	Over 20% of adults globally do not meet the World Health Organisation (WHO) Global Recommendations on Physical Activity for Health (WHO figures). Golf is popular in some regions where physical inactivity prevalence is high (North America, Europe, Australasia).	0.00%	4.00%	0.00%	60.00%	36.00%	96.00%
27	Of the over 60 million persons that have played golf at least twice in the previous year, participation is currently highest in North America, Australasia and Europe, in males compared with females, in middle aged and older adults, in some ethnic groups (White-European Heritage) and in those of middle and higher socio-economic class (R&A, and Sports Marketing Suveys Inc. data).	0.00%	0.00%	4.00%	56.00%	40.00%	96.00%

b. Correlators and mediators

Question No.	Item	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree	% Agree/ Strongly Agree
28	There is a need for an inclusive environment within golf that embraces, encourages and welcomes individuals, groups and families from all of society.	0.00%	0.00%	0.00%	32.00%	68.00%	100.00%
29	Some factors that help interest and participation in the sport, are that golf can i) be enjoyable, ii) be played throughout life, iii) offer a sense of community, iv) offer challenge and/ or competition, v) provide outdoor exercise and vi) provide time for self.	0.00%	0.00%	4.00%	20.00%	76.00%	96.00%
30	Golf can also teach life skills, while facilities can provide a social/ community hub.	0.00%	0.00%	0.00%	32.00%	68.00%	100.00%
31	Golfers with a disability can play equitably with able-bodied golfers or golfers with other types of disabilities at some courses/ facilities.	0.00%	4.00%	8.00%	48.00%	40.00%	88.00%
32	Some factors that may hinder interest and participation in the sport, include perceptions that it is expensive, less accessible for those from lower socio-economic groups, male dominated, for older people, or difficult to learn.	0.00%	0.00%	0.00%	36.00%	64.00%	100.00%
33	The cost of playing golf can hinder participation in some countries and at some facilities, while other facilities do offer affordable health enhancing physical activity.	0.00%	0.00%	0.00%	32.00%	68.00%	100.00%
34	Physical proximity to a facility, transport options and playing restrictions can be barriers to participation.	0.00%	0.00%	4.00%	40.00%	56.00%	96.00%
35	Shorter forms of the sport, and efforts to avoid excessively slow play can offset the length of time and offer alternatives to those where time constraints are a barrier to participation.	0.00%	0.00%	0.00%	44.00%	56.00%	100.00%
36	Efforts to provide an infrastructure, social norms and regulations that are welcoming to all can lower barriers to participation.	0.00%	0.00%	4.00%	52.00%	44.00%	96.00%
37	Not everyone will be attracted by the same things at a golf facility, so diversity and specialisation of golf facilities in keeping with the local context, culture and population is appropriate.	0.00%	4.00%	8.00%	48.00%	40.00%	88.00%
38	Some reported aspects that can contribute to people stopping playing golf include i) takes too much time from the family; ii) too expensive; iii) too long to play 18 holes; iv) tried but didn't have fun; v) considered too difficult and takes too long to learn; vi) health concerns and vii) fear of being embarrassed.	0.00%	0.00%	4.00%	32.00%	64.00%	96.00%

c. Golf and sustainability

Question No.	Item	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree	% Agree/ Strongly Agree
39	Golf can promote sustainability through practices that prioritise diversity, healthy societies, environmental integrity and health and well-being	0.00%	0.00%	0.00%	56.00%	44.00%	100.00%

DOMAIN 3: INTERVENTIONS AND KNOWLEDGE TRANSFER

a. Interventions

Question No.	Item	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree	% Agree/ Strongly Agree
40	nterventions to make the sport more inclusive, and welcoming should be supported.	0.00%	0.00%	4.00%	28.00%	68.00%	96.00%
41	More interventions are required to increase access and participation, building on theories around engagement, enjoyment, and including effective monitoring and evaluation aspects.	0.00%	0.00%	4.00%	44.00%	52.00%	96.00%
42	The health benefits of golf can be enhanced by appropriate partnerships within and outwith the golf sector (for example with health or educations sector organisations).	0.00%	0.00%	0.00%	56.00%	44.00%	100.00%

b. Actions for golfers / participants

Question No.	Item	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree	% Agree/ Strongly Agree
43	Golfers should aim to play golf at least 150 minutes per week, or engage in other forms of moderate to vigorous physical activities additional to golf	0.00%	0.00%	0.00%	56.00%	44.00%	100.00%
44	Golfers should be encouraged to walk the course, as opposed to riding a golf cart to obtain optimal health benefits if able.	0.00%	0.00%	0.00%	36.00%	64.00%	100.00%
45	Golfers should be encouraged to make others feel welcome, and support others to enjoy golf.	0.00%	0.00%	0.00%	32.00%	68.00%	100.00%
46	Golfers should warm up with some aerobic exercise, then golf specific mobility exercises, then practice swings to maximise performance and minimise injury risk.	0.00%	0.00%	0.00%	52.00%	48.00%	100.00%
47	Golfers should be encouraged to maintain hydration (drinking when thirsty, and having fluids available) while on the course, particularly in hot and/ or humid conditions.	0.00%	0.00%	0.00%	24.00%	76.00%	100.00%
48	Appropriate strength and conditioning exercises can decrease injury and illness risk, and improve performance	0.00%	0.00%	0.00%	36.00%	64.00%	100.00%
49	Golfers should utilise sun-screen and appropriate clothing (collared shirt, hat, etc) as appropriate, and moderate exposure to direct sunlight	0.00%	0.00%	0.00%	24.00%	76.00%	100.00%
50	Education should be sought regarding playing safely. Children should be adequately supervised.	0.00%	0.00%	0.00%	56.00%	44.00%	100.00%
51	Spectators at golf tournaments can be encouraged to walk, and spectate in an active fashion	0.00%	0.00%	0.00%	52.00%	48.00%	100.00%
52	Golfers should follow appropriate lightning safety guidelines, and discontinue play if there is danger from lightning.	0.00%	0.00%	4.00%	16.00%	80.00%	96.00%
53	Golf carts when driven should be done so responsibly, and following local guidance including minimum age requirements.	0.00%	0.00%	0.00%	28.00%	72.00%	100.00%
54	Golfers with cardiovascular disease can play with acceptable safety, but should see a doctor should symptoms increase or be unstable.	0.00%	0.00%	4.00%	32.00%	64.00%	96.00%
55	Golfers can be expected to return to golf following total knee, hip, or shoulder replacement, with a graduated return to golf.	0.00%	0.00%	0.00%	56.00%	44.00%	100.00%

c. Actions for golf facilities / the golf industry

Question No.	Item	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree	% Agree/ Strongly Agree
56	Golf facilities and the golf industry should communicate key actions related to golf and health to players, and potential players in a consistent and engaging fashion, appropriate to their context.	0.00%	0.00%	0.00%	48.00%	52.00%	100.00%
57	Grassroots initiatives supporting development of golf in regions/ countries where golf is a relatively new sport can help encourage growth in these areas	0.00%	0.00%	0.00%	56.00%	44.00%	100.00%
58	Golf facilities and the golf industry should build on existing initiatives promoting inclusivity, and encourage increased participation by developing environments and price structures that are welcoming to all.	0.00%	0.00%	0.00%	40.00%	60.00%	100.00%
59	Golf facilities and other golf industry leaders and stakeholders should commit and can work together to develop an environment that will inspire and recruit more women and girls to play golf, and retain their participation in the game.	0.00%	0.00%	4.00%	28.00%	68.00%	96.00%
60	Golf facilities and the golf industry should encourage effective learning and coaching environments, and support entry level play, building on existing initiatives.	0.00%	0.00%	4.00%	40.00%	56.00%	96.00%
61	Golf facilities should consider the preferences of the average golfer when setting up the golf course, e.g. length of holes and course, depth and nature of rough, severity of hazards, hole positions, and where necessary make adjustments.	0.00%	0.00%	20.00%	32.00%	48.00%	80.00%
62	Facilities should make every effort to promote equality and diversity, and make golf accessible.	0.00%	0.00%	0.00%	32.00%	68.00%	100.00%
63	Golf facilities where possible should consider being multi-functional (having facilities in addition to golf- for example gym, walking routes or child care) and having diversity of golf facilities.	0.00%	0.00%	12.00%	56.00%	32.00%	88.00%
64	Golf facilities and the golf industry should promote practices that enhance sustainability, -maximising opportunities for wildlife conservation, interaction with green space, restricting water, energy and pesticide/chemical use.	0.00%	0.00%	0.00%	48.00%	52.00%	100.00%
65	Golf facilities should be encouraged to provide information and facilities to support golfers warming up to play.	0.00%	0.00%	0.00%	56.00%	44.00%	100.00%
66	The golf industry/ golf facilities should encourage players to walk the course if able, and avoid mandatory golf cart use at facilities.	0.00%	0.00%	4.00%	36.00%	60.00%	96.00%
67	The golf industry/ golf facilities can encourage and facilitate regular physical activity, and other health enhancing behaviours (for example healthy eating).	0.00%	0.00%	4.00%	44.00%	52.00%	96.00%
68	The golf industry should educate and protect employees and golfers about the risks of excess sun exposure.	0.00%	0.00%	4.00%	40.00%	56.00%	96.00%
69	Golf facilities should stock sun-screen, hats and collared shirts.	0.00%	4.00%	4.00%	56.00%	36.00%	92.00%
70	Golf facilities and the golf industry should continue to support Health and Safety regulations, membership of professional organisations, education relating to safe play, and ensure adequate supervision of children	0.00%	0.00%	4.00%	52.00%	44.00%	96.00%
71	Golf facilities should consider providing cardio-pulmonary resuscitation (CPR) training to staff, and provide Automatic External Defibrillators.	0.00%	0.00%	8.00%	32.00%	60.00%	92.00%
72	Golf carts should be well maintained, with speed limiters, and front wheel brakes.	0.00%	0.00%	8.00%	44.00%	48.00%	92.00%
73	Appropriate lightning safety policies and education should be enacted at each facility. Guidance for appropriate action for players should be highlighted by golf facilities, and the golf industry.	0.00%	0.00%	4.00%	28.00%	68.00%	96.00%

d. Actions for policy / decision makers (outwith golf sector)

Question No.	Item	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree	% Agree/ Strongly Agree
74	The benefits of regular physical activity including playing golf should be communicated and promoted regularly for persons of all ages, genders, and socio-economic backgrounds.	0.00%	0.00%	0.00%	36.00%	64.00%	100.00%
75	Cross –sectoral policies should be delivered that support the World Health Organisation Global Action Plan on Physical Activity, and the United Nations Sustainable Development Goals.	0.00%	0.00%	8.00%	44.00%	48.00%	92.00%
76	Policy makers can be confident golf can provide health enhancing physical activity to persons of all ages, and genders. Policy documents, frameworks and actions should support this.	0.00%	0.00%	0.00%	40.00%	60.00%	100.00%
77	Policy makers should where relevant include golf as a moderate intensity physical activity in policy documents, guidance and recommendation, and encourage participation for persons of all ages and genders.	0.00%	0.00%	0.00%	33.33%	66.67%	100.00%
78	Policy should support play by diverse geographical, and socio-economic participants, of all genders, ages and abilities	0.00%	0.00%	0.00%	33.33%	66.67%	100.00%
79	Policy documents, frameworks and actions can where relevant usefully acknowledge green space, health and well-being, nature connection, social and community, local and national economic benefits of golf.	0.00%	0.00%	4.00%	32.00%	64.00%	96.00%
80	Policy makers should support efforts to encourage spectators to be physically active (for example walking the course) at golf and other sporting events.	0.00%	0.00%	0.00%	48.00%	52.00%	100.00%
81	Policies should promote multi-functionality (having facilities in addition to golf) and diversity of facilities where possible, and sustainable practices	0.00%	0.00%	16.00%	40.00%	44.00%	84.00%
82	Policy makers should work collaboratively with the golf industry and national associations to promote increased participation in physical activity/ golf, particularly in groups with low levels of physical activity.	0.00%	0.00%	4.00%	40.00%	56.00%	96.00%
83	Policy makers, governing bodies and the golf industry can work collaboratively to gain acceptance from the International Paralympic Committee that golf be included in the Paralympics	0.00%	0.00%	8.33%	41.67%	50.00%	91.67%

Appendix 17. Updated status of research priorities identified in 2016 Scoping Review.
(Published in Consensus as Appendix 1, reproduced with permission).

Research Priority relating to Golf and Health	2016 Comment from Scoping Review (Murray et al 2016)	Activity 2016-2018
Mental health and illness.	Physical activity has an overall positive impact on wellness, and mental ill health, but robust, controlled studies with objective measures are required in relation to golf. Weight of evidence low.	Randomised Control Trials. Completed. Golf and cognitive decline. Shimada 2018 Underway. Golf and dementia. Hewson et al. Cross Sectional. Completed. Golf and mental well-being. UK Active 2018. Further detailed research proposals in Australia, France and the UK have been submitted for funding or have been funded.
Systematic reviews relating to golf and health.	To explore cause and effect nature of the relationships described.	Further research to support these reviews required. Systematic review of injuries in professionals completed (Robinson et al 2018)
Muscle strengthening/ strength and balance/ musculoskeletal benefits	Research on the contribution of golf to muscle strengthening/ strength and balance, and potential effects in relation to osteoporosis and osteoarthritis could be important to golfers, practitioners and policy makers looking to provide advice to patients and populations.	Completed Small interventional (DuBois et al 2018,) and cross-sectional (Stockdale et al 2017) studies have been conducted. Underway Research funding has been secured by the Golf and Health team to assess strength and balance in golfers compared to controls in a RCT.

	Weight of evidence low/ knowledge gap.	
Golf-carts	Research is needed exploring how health effects/ relationships differ between golf played while riding a golf- cart, and golf played walking the course. Weight of evidence low.	Cross-sectional (Completed, being written up) Golf-carts versus walking distance, energy expenditure. Exercise intensity. Jayabalan 2018. Golf carts and utility for Osteo-arthritis. Jayabalan 2018.
Golf Spectating	Research assessing useful physical activity accrued spectating is required. Opportunities exist to shape health behaviours amongst spectators both on course, and in daily life using the experience as a 'teachable moment'. Knowledge gap.	Cross-sectional (completed) Spectators rate physical activity as important reason for spectating. Spectators gain HEPA while spectating (Murray 2017) Receiving PA messaging at golf tournaments can influence subsequent attitudes and behaviours re PA. (Murray et al 2019)
Health behaviour change.	Research is needed addressing how golfers and potential golfers can be influenced to take part and maintain golfing activity, and investigating and improving knowledge and behaviours related to golf injuries, illnesses and accidents. Weight of evidence low.	All completed. Consensus. Provision of action plans for golfers, the industry and policy makers (Murray et al 2018) Intervention Golf on referral studies (UK Active 2018, and other unpublished.) Golf and youth participation. (Go Golf Europe, unpublished) Intervention Receiving PA messaging at golf tournaments can influence subsequent

		<p>attitudes and behaviours re PA. (Murray et al 2019)</p> <p>Understanding behaviours.</p> <p>Why older adults golf? (Stenner 2016, and ongoing, GoGolf Europe.)</p>
Economic effects	<p>Research investigating cost savings to health and other services associated with golf, and opportunities to make golf more accessible and affordable for all will inform policy.</p> <p>Weight of evidence low.</p>	<p>Cross-sectional data with basic economic analysis (UK Active 2018)</p> <p>Commitment by global golfing bodies regarding improved access for women and girls, those with disabilities, and those new to the sport</p>
Specific populations.	<p>Research addressing associations between golf and health in a) disabled and b) older adult populations may highlight specific benefits/ dis-benefits.</p> <p>Weight of evidence low.</p>	<p>Children/ youth</p> <p>Go Golf Europe Project (publications pending)</p> <p>Older Adults</p> <p>Cross sectional- Why older adults play golf. (Stenner 2016)</p> <p>Longitudinal/ RCT- Mental and Physical health. Older adults. Golf. Funded research in Australia, USA, and UK</p> <p>Disability</p> <p>29 national organisations commit to developing golf in players with disability.</p> <p>Research collaborations and opportunities identified.</p> <p>Integration of elite disability players into a professional tournament 2018/ 2019.</p>

Appendix 18. Scoping review. Uptake from social media and media captured by publishing journal.

Image 1. Capture of 99 news stories, and examples.

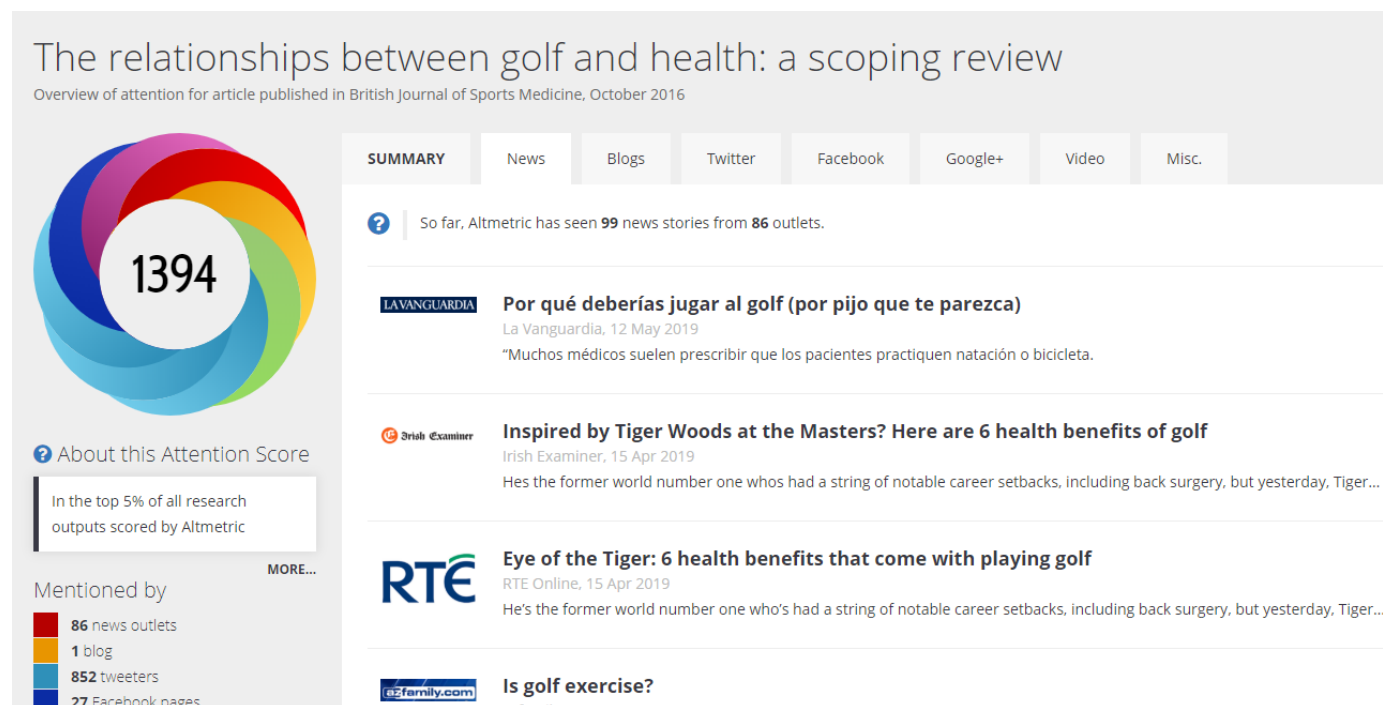
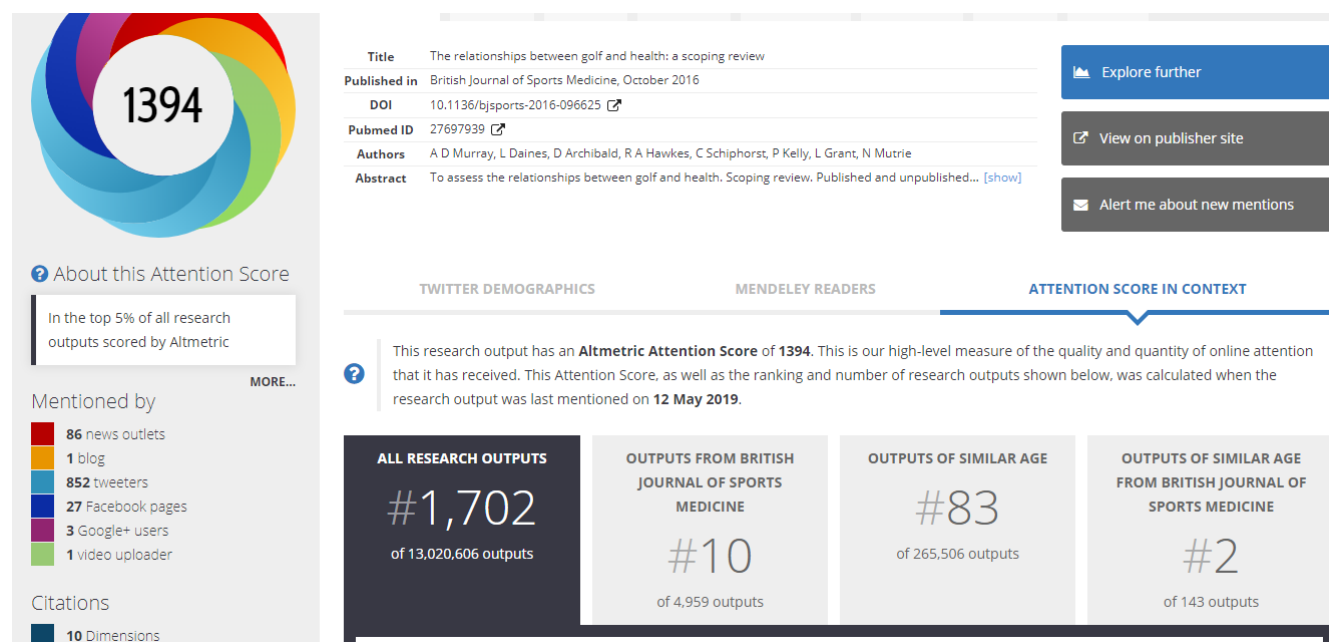


Image 2. Information regarding Altmetric, and comparrison with other scientific publication.



Appendix 19. Scoping Review, example of uptake use and impact. UK Parliament.

EARLY DAY MOTION. October 2016.

GOLF AND HEALTH

That this House notes with interest and welcomes a scientific review relating to golf and health. This study outlines that while the 55 million golfers worldwide may not win the Ryder Cup, or indeed the Open Championship, they can gain the same benefits the players obtain through golf including better physical and mental health outcomes and likely longer life. Moreover, this review conducted by the University of Edinburgh, and published in the British Journal of Sports Medicine, the number one ranked sports journal worldwide highlights golf can provide moderate intensity physical activity, which is advocated by the World Health Organisation, and our four home nations Chief Medical Officers. This report is being widely shared by player ambassadors such as Annika Sorenstam , Gary Player, Padraig Harrington as well as members of our European and United States Ryder Cup teams. This house looks forward to widely sharing the health benefits of golf which can be played from 4 years old to 104, considering its implications, and hearing of future research from this group. This house further welcomes the collaborative approach highlighted thus far by the World Golf Foundation, the R&A, PGAs of Europe, the European Tour, and the Universities of Edinburgh and St Andrews.

Appendix 20. Uptake, use and impact. Spectator Health. Press release and examples of press activity

Press release from University of Edinburgh re spectator health observational paper.

Better health is par for the course for golf fans, study shows

Golf fans may be among the fittest of all sporting spectators, a new study suggests.

Most people who attend golf events exceed recommended daily step counts, researchers found.

A survey of spectators at last year's Paul Lawrie Match Play event at Archerfield Links, East Lothian, found that they averaged about 11,500 steps per day.

Male spectators took about 1800 more steps each day than women, according to pedometer data, the study found.

Of those surveyed, 60 per cent said they would like to be more physically active.

Step-count data

The study, published ahead of this week's Ricoh Women's British Open at Kingsbarns, is the first to use step-count data to assess golf spectators' physical activity.

Health and golf bodies may wish to further promote the benefits of spectating, researchers from the University of Edinburgh suggest.

Their findings could encourage a wider audience to enjoy the health benefits of golf spectating, researchers say.

Health benefits

Researchers and policy-makers agree that regular physical activity can improve mental health, physical health and life expectancy for people of all ages and backgrounds.

More than 10 million people spectate at golf tournaments each year, with the opportunity to improve their health while watching their sporting heroes.

The survey also found that spectators rate exercise and physical activity as important reasons for attending golf tournaments.

Fans also say attending events allows them to enjoy being in the fresh air, spending time with friends and family and watching star players.

Golf playing and spectating is particularly popular in middle aged and older adults in North America, Europe and Asia. This demographic typically has lower levels of physical activity compared with younger adults and children.

Anecdotal evidence found that spectators at the 2014 Ryder Cup at Gleneagles collectively walked a distance equal to four times around the world. Fans at China's Shenzhen International in 2016 walked the equivalent length of the Great Wall seven times.

The health benefits for spectators at tournaments may vary depending on weather conditions, culture, types of tournament and golf course terrain.

The study, published in the British Journal of Sports Medicine, and BMJ Open Sports and Exercise Medicine is part of the Golf & Health Project, which is led by the World Golf Foundation. The initiative aims to increase the understanding of golf in health and wellbeing.

Walking is one of the best things you can do for your health, adding years to life, and increasing health and happiness. These pilot findings show that golf spectators can gain physical activity which could benefit their health- while watching top quality sport at close quarters.

Dr Andrew Murray Physical Activity for Health Research Centre, the University of Edinburgh
It is great to hear that the work we are doing to promote active spectating at events like the Ryder Cup, the Shenzhen International and the Paul Lawrie Match Play is being backed up by this research.

Image 1. Feature in the Times newspaper and online.

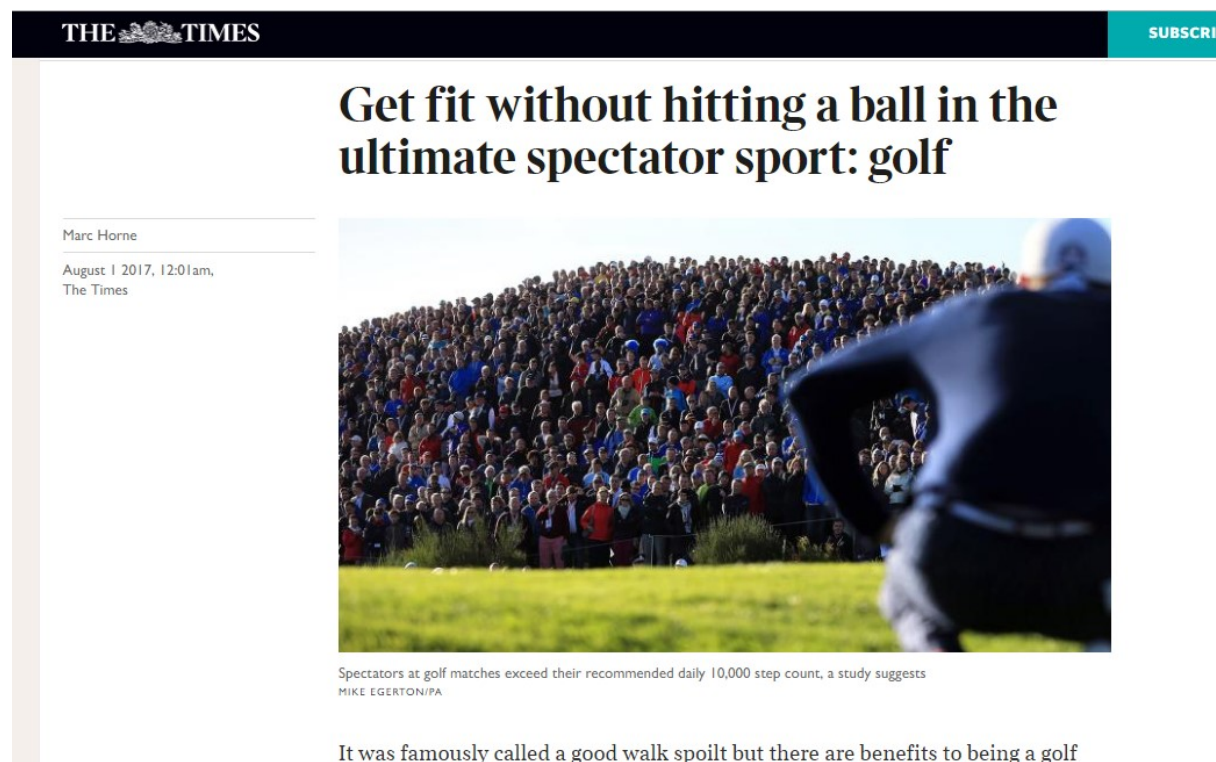


Image 2. Example of content on British Broadcasting Corporation (BBC) website also featured on BBC radio broadcasts.



Appendix 21. Uptake, use and impact. Spectator Health. UK Parliamentary support and Early Day Motion.

UK Parliament Hails Health Benefits For Golf Spectators



Members of Parliament have hailed the potential health benefits of spectating at golf events.

A motion has been tabled in the House of Commons welcoming recent research into the potential health benefits to spectators across the world. A study by **Professor Nanette Mutrie, Dr Andrew Murray** and colleagues, published in the British Journal of Sports Medicine, showed that spectators take an average of over 11,000 steps while walking the course.

This study builds on a range of research conducted by Golf & Health, a project that has brought together golf organisations from across the world, and which aims to raise awareness of the health benefits that golf can deliver to people of all ages and backgrounds.

The motion “encourages others to make the most of the associated health benefits UK-held tournaments held by the Royal and Ancient (The R&A), the European Tours and the PGAs of Europe offer”.

Tabling the motion was All-Party Parliamentary Golf Group Co-Chair and Member of Parliament for North East Fife, **Stephen Gethins MP**. He said “this latest research from the Golf and Health project into the health benefits to golf spectators is very welcome. Golf clearly has overall health benefits for participants, but the potential for health-enhancing physical activity for golf spectators is unique in sport.”

“This research shows that those attending golf tournaments across the UK can enjoy health benefits from walking the course with their sporting heroes, and I hope that more people will be encouraged to do so. I look forward to continuing to work closely with the Golf and Health Project, and with all Members of the All-Party Parliamentary Golf Group, to ensure that health benefits to both participants and spectators are clear to policymakers.”

The full text of the motion is as follows:

Early day motion 362 – POTENTIAL HEALTH BENEFITS OF SPECTATING AT GOLF EVENTS

That this House welcomes the recent publication of scientific papers relating to the potential health benefits to the world’s over-10 million spectators attending golf tournaments; notes a recent study by **Professor Nanette Mutrie, Dr Andrew Murray** and colleagues published in

the British Journal of Sports Medicine which showed that spectators take an average of over 11,000 steps while walking the course and, as well as observing leading players in this fashion, are more likely to have an active interest in gaining physical activity and spending time with their families; further notes this builds on a review conducted by the University of Edinburgh and published 2016 in the British Journal of Sports Medicine which highlighted that golf can provide moderate intensity physical activity as advocated by the World Health Organisation and the UK's four chief medical officers; is pleased that these reports are being widely shared by player ambassadors such as **Annika Sorenstam**, **Gary Player**, **Padraig Harrington** as well as current world number one **So Yeon Ryu**; encourages others to read these reports and consider their implications; looks forward to future research in this area; further encourages others to make the most of the associated health benefits UK-held tournaments held by The Royal & Ancient Golf Club of St Andrews (The R&A), the European Tour and the PGAs of Europe offer; and further welcomes the the collaborative approach of the World Golf Foundation, The R&A, PGAs of Europe, the European Tour, Paths for All and the Universities of Edinburgh and St Andrews have shown to date and ongoing.

Appendix 22. Uptake, use and impact. Spectator Health. Examples of implementation at The Open Championship, Solheim Cup, and Women's British Open.

The Open Championship information tower and big screen content



THE OPEN

Golf and Health

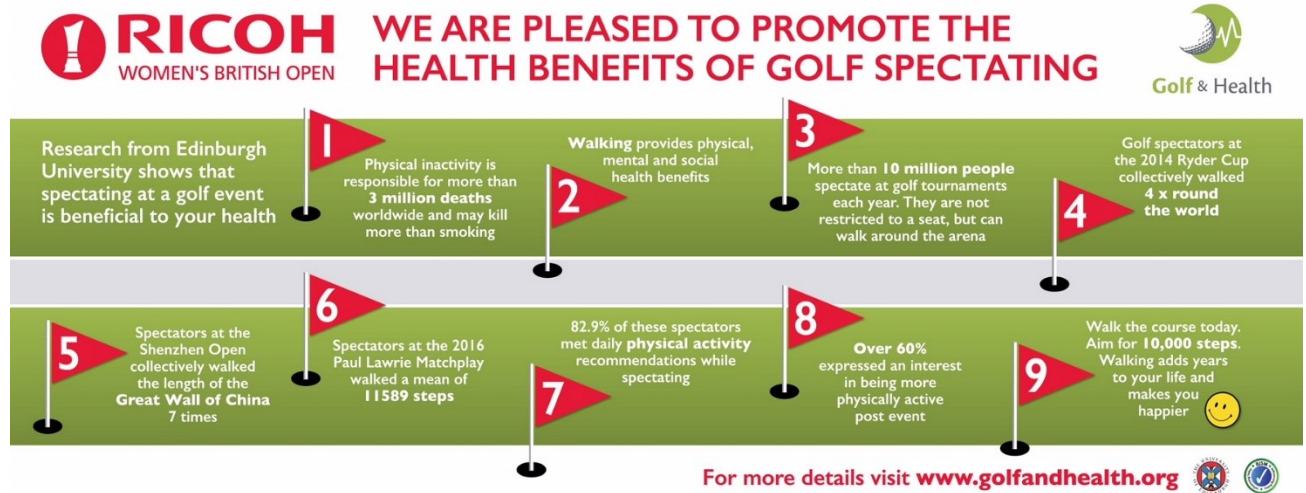
Did you know...

... even spectating is good for you? If you follow the entire spectator Red Route at Carnoustie you will walk over the recommended 10,000 daily steps (approx 6km in total).

R&A

 **Golf & Health**

Example of use at Women's British Open.



Example of use at Solheim Cup Cup pre-event advertising



Appendix 23. Uptake, use and impact. Consensus. Report of press activity by Dr Jonathon Greenspan.

Report on global press coverage for the International Consensus Statement on Golf and Health 2018 for The R&A and World Golf Foundation

Dr Jonathon Greenspan

Introduction:

On September 23, the British Journal of Sports Medicine (BJSM) published the 2018 International Consensus Statement on Golf and Health (ICS), compiled from 25 experts on sports medicine, public health and golf. Due to the global nature of both the game and medical research, the publication has had extensive worldwide coverage, both in traditional media (particularly print, TV and radio) and web-based sources. In this report, the global coverage will be demonstrated by modality, country of report and also potential coverage regions.

Method:

The search was completed over a several week period up to December 12th 2018, using online search engines in English with limited searches in Spanish and French. In addition, further press coverage was identified using the Altmetric.com function embedded within the BJSM article.

Data:

As of December 11th 2018, the BJSM International Consensus on Golf and Health article had been reported by 139 different media sources across the globe. Of these, 128 were in English, 9 in Spanish and 2 in French. Coverage on the ICS had been based in 18 countries, displayed in *Figure 1*, below (a complete list of the countries can be found within Appendix A):

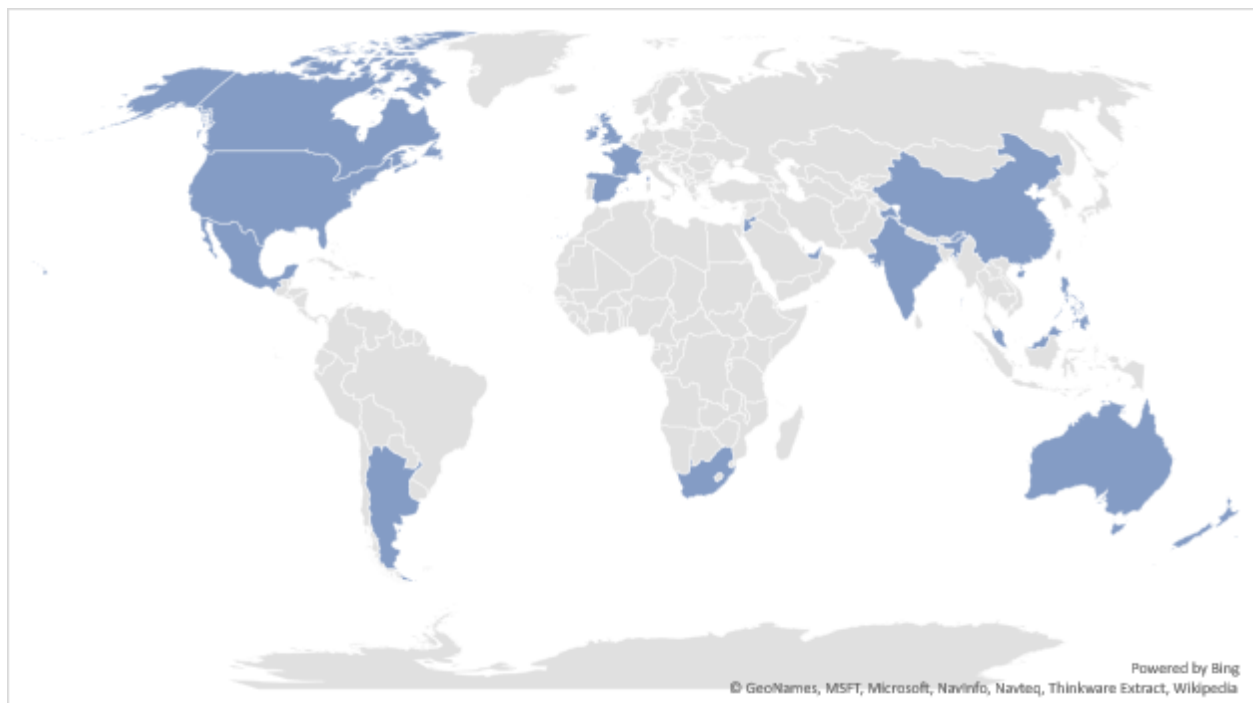


Figure 1: Map showing the countries of origin for press coverage of the ICS.

Additionally, while the countries of origin for the media coverage is shown above, many of the media sources had coverage regions beyond their borders. For example, Channel News Asia is based in Singapore, however they have offices and distribution across more than 20 countries in Asia where their report could potentially have been read. The total potential coverage regions for the media sources reporting on the ICS currently totals 64 countries as of the most recent searches, this is shown in *Figure 2*, below:

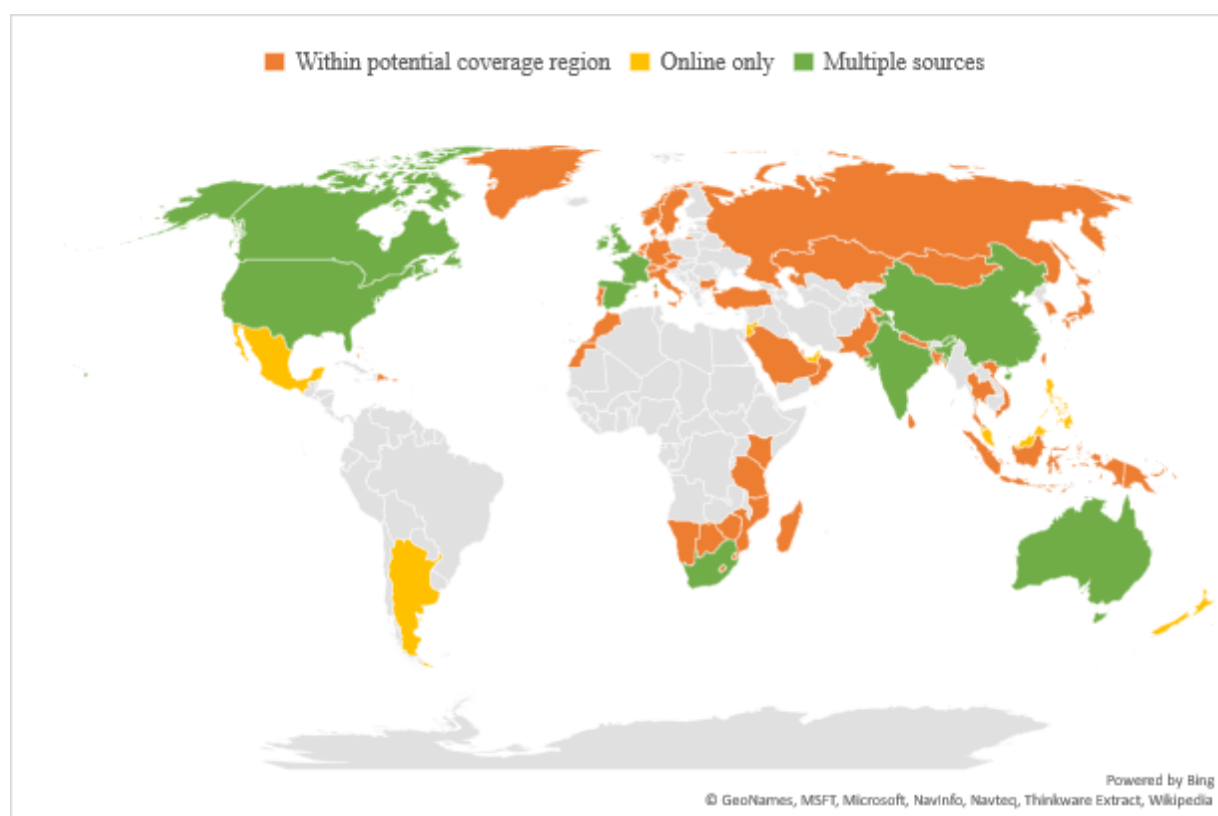


Figure 2: Map illustrating global coverage of the ICS including potential media coverage regions.

The ICS coverage can be further stratified by type of media (traditional vs online) and further divided by which media format was used and if the media was golf-based or general news.

<u>Type of media</u>	<u>Number of releases</u>
Print	11
Radio	5
TV	2
Online news (many of which also Print)	117
TV and Online combination	4
Golf media	33
Non-golf media	106

Countries with traditional media coverage all had online coverage of the ICS. Statistics on viewership for each online source were not readily available. However, using an online traffic monitoring website (Similarweb.com), it was possible to obtain the approximate site traffic to some sources' homepage/ domain in the month of November 2018 for 62 of the

English-language sites (58.5%), with data more readily available for large national sources. **In total, a cumulative traffic of just over 1.8 billion visits were performed across the homepages of English-language websites reporting on the ICS. Notable news sources include NDTV (based in India with an online readership of 181M), Channel News Asia (based in Singapore with an online readership of 149M in November), the Mail Online (based in UK with 276M visitors in November) and MSN (based in the US with 854M visitors in November).** Golf-specific media domains (not including general sports media) had a cumulative online traffic of almost 16.1M in November 2018.

Between publication and November 30th 2018, the ICS was downloaded from the BJSM website 5085 times, in the top 5% of articles. The abstract was viewed 5119 times during this same period. There were no published responses on the BJSM at the time of search.

Discussion and conclusions:

It is apparent from the data that the ICS has had widespread global coverage with media coverage in 6 continents. The coverage of the ICS on television in major markets (the metropolitan areas of New York, London, Miami, San Antonio and Philadelphia alone represent a population of approximately 48M people) and on radio (such as BBC Radio Scotland during prime rush hour and BBC Sportsworld Online) cannot be understated. Additionally, the sharing of the ICS on social media, by well-known sources such as Gary Player, Annika Sorenstam, BASEM and others would have significantly increased readership in addition to traditional and online reporting (Player and Sorenstam have over 500 000 followers between them).

A small concern was the relatively high proportion of online sources being golf specific (30%), which could potentially indicate that while the information dissemination was widespread amongst the golfing community, the ICS could possibly have had less of an effect on non-golfers starting the sport for health benefits.

Further searches are warranted in 3-6 months (and in more languages) to assess if the information contained in the ICS is still being disseminated and if golf participation is up. In future it could also be worth assessing the effect of social media on the spread of the ICS and its information. Overall, early indications are very supportive of strong potential global coverage of the ICS with potential website traffic of the sources reporting on it in excess of 1.8 billion visits a month. Whilst there would likely be significant overlap between sources in terms of visitors, the potential reach of the information within the ICS is clearly significant.

Appendix A:

List of countries where news/ media coverage of the ICS was based, excluding global or regional sources:

<u>Country</u>	<u>Number of sources</u>
Argentina	1
Australia	16
Canada	3
China	2
France	2
India	12
Ireland	4
Jordan	1
Malaysia	1
Mexico	1
New Zealand	1
Philippines	1
Singapore	1
Spain	7
South Africa	2
UAE	1
UK	46
USA	25

Appendix 24. Uptake and use. Consensus statement. Examples of social media interaction.

Includes major broadcasters, multiple major champions both female and male, Ministers for Public Health, National Golf Federations, the World Golf Foundation Chief Executive, leading doctors, and academic journals.

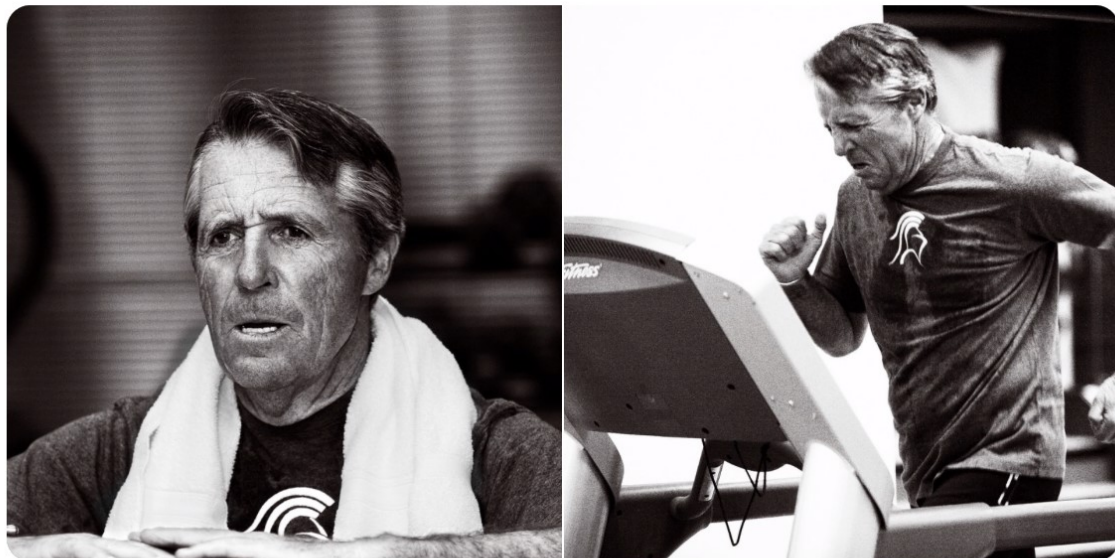


Gary Player 
@garyplayer

Following



There are various events happening right now in London where [@WHO](#) [@ISPAH](#) and the UK government are internationally recognizing golf as being a health-enhancing activity! Check it out at golfandhealth.org.
[#GolfandHealth](#)



11:17 am - 17 Oct 2018

24 Retweets 151 Likes





Morning Drive ✓

@GCMorningDrive

Following



Golf has proven to benefit both physical and mental health. @ANNIKA59 joined Morning Drive to discuss this finding:
watchgolf.ch/Ohc8UQ



1:30 pm - 19 Oct 2018

5 Retweets 30 Likes





Golf Canada

@TheGolfCanada

Following



Leaders in public health and the world of sport have backed **#golf** in the race to tackle physical inactivity. **#GolfandHealth**
#ISPAH2018

Details ow.ly/2eb330mgLiV



8:20 am - 20 Oct 2018

4 Retweets 15 Likes





Zach Johnson 
@ZachJohnsonPGA

Following



There are various events happening right now in London where [@WHO](#), [@ISPAH](#), and the UK government are internationally recognising golf as being a health-enhancing activity. Check it out at golfandhealth.org.
[#GolfandHealth](#)



Golf & Health

Exploring the Health Benefits of Golf
golfandhealth.org

8:59 am - 17 Oct 2018

13 Retweets 30 Likes





Steve Mona

@stevemona1

Following



There are various events happening right now in London where @WHO, @ISPAH and the UK government are internationally recognizing golf as being a health-enhancing activity. Check it out at golfandhealth.org.
[#GolfandHealth](https://twitter.com/hashtag/GolfandHealth)



Golf & Health

Exploring the Health Benefits of Golf

golfandhealth.org

6:30 am - 17 Oct 2018

7 Retweets 11 Likes





Scottish Golf 
@ScottishGolf

Following



| Golf has key role to play in the race to tackle physical inactivity, say leaders in public health, public policy and sport

[#GolfandHealth](#) [#ISPAH2018](#)

[#WellnessWednesday](#) [@GolfAndHealth](#)

[@WHO](#) [@RandA](#) [@ISPAH](#) bit.ly/2AhkhKZ



8:24 am - 17 Oct 2018

5 Retweets 14 Likes





Dfisio Clinicas
@Dfisioclinicas

Following



Sabias que jugar al golf nos hace más sanos y felices?!? @EuropeanTour
@Etpi @GolfAndHealth #golfandhealth #golf
#fisiodegolf

Translate Tweet



9:10 am - 19 Oct 2018 From Madrid, España

2 Retweets 8 Likes





Kush Joshi
@DrKushJoshi

Following



Great to be invited to The First International Congress on **#GolfAndHealth** by **@DocHawkes** at **@UKParliament** and **@HighElmsGolf** - Some fantastic initiatives being driven by those working in golf to improve **#physicalactivity**



9:34 am - 18 Oct 2018

1 Retweet 20 Likes





Prakash Jayabalan
@pjayabalanMDPhD

Following



Wonderful to represent @AbilityLab at such a terrific meeting. Thank you @GolfAndHealth for the opportunity! #Physiatry #golfandhealth



Golf & Health @GolfAndHealth

The great Dr @pjayabalanMDPhD from the Shirley Ryan @AbilityLab in Chicago, USA, joins us at the Scientific Meeting to talk through his research on golfers with knee #osteoarthritis and whether it is a barrier to golf... (it's not!)

3:34 pm - 18 Oct 2018 From Camden Town, London

1 Retweet 14 Likes



1



14





ukactive 
@_ukactive

Following



Replying to [@GolfAndHealth](#) [@WHO](#) [@ISPAH](#)

Our 'Golf on Referral' report with [@englandgolf](#) + [@mytimeactive](#) found participants had increase in vigorous exercise per week + reductions in both systolic blood pressure.

[#ResearchInstitute](#)'s [@_MattWade](#) to touch on more shortly [#GolfAndHealth](#) [#ISPAH2018](#)



Getting back in the swing: GPs urged to refer older patients for golf lessons |...

Health professionals are being urged to refer older and inactive patients for golf lessons, after a new report showed that golf builds muscle strength and...

[ukactive.com](#)

6:59 am - 18 Oct 2018

3 Retweets 4 Likes





BJSM Plus
@BJSMPlus

Following



Golf a real leading light when it comes to investigating the health outcomes of participation

Fascinating insight into the science behind the studies, and how to advance the field

@docandrewmurray @GolfAndHealth
#ISPAH2018 #GolfAndHealth



BJSM ✓ @BJSM_BMJ

One round of golf can meet weekly MVPA targets (15mins/week)



Improvement in flexibility & stability ✓...

2:01 am - 18 Oct 2018 From London, England

1 Retweet 3 Likes





Steve Brine MP  @BrineMP · Oct 17

So fantastic to be part of the new global consensus amongst leaders in public health, public policy and sport today as we back golf in the race to tackle physical inactivity and the prevention agenda. @GolfAndHealth @RandA @ANNIKA59 #ISPAH2018



Steve Brine MP  @BrineMP · Oct 17

Have a fantastic time all and congratulations

Golf & Health Retweeted



BC Golf @bc_golfer · Oct 18

Together with @RANDA the #GolfandHealth Project are working with @WHO, @ISPAH, and governments to show golf is officially recognized as a health-enhancing physical activity, which will have a big effect both in and out of our sport! golfandhealth.org #GolfandHealth



1 2

Golf & Health Retweeted



Golf Australia @GolfAust · Oct 22

Golf your ticket to better health! Here's the proof and why you should start swinging ASAP!!

golf.org.au/newsdisplay/10... via @RandA @SpargoJill



Golf the ticket to better health

World public health leaders have backed golf as a prime vehicle to tackle serious health issues.

golf.org.au

1 8 13

Golf & Health Retweeted



PGA of Canada @pgaofcanada · Oct 17

Global consensus for golf in the race to tackle physical inactivity

READ MORE: bit.ly/2I3o9In

